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TREASURY

OF

KNOWLEDGE.

In Three Parts.

I.

ELEMENTARY LESSONS IN COMMON THINGS.

II.

PRACTICAL LESSONS ON COMMON OBJECTS.

III.

INTRODUCTION TO THE SCIENCES,

BY

William Robert

W. & R. CHAMBERS.

CHAMBERS' EDUCATIONAL COURSE,

ENLARGED AND IMPROVED

David Meredith

BY D. M. REESE, M.D. LL.D.

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INTRODUCTORY OBSERVATIONS

BY

THE AMERICAN EDITOR.

THIS volume is designed and calculated for an early reading-book, to be placed in the hands of children as soon after they learn to read as practicable. It will be found equally interesting to children, and vastly more profitable, than books containing childish stories, and senseless fictions, such as those too frequently used in schools. Of many such, it is not too much to say that they are not merely useless, but injurious to the minds of youth, creating a taste for the trifling and laughable, and leading them to look for amusement rather than instruction in their books. Can it be doubted that the fondness for works of romance and fiction shown by many young persons, has its origin in the early habit of finding their books in school to afford them any thing but truth, and often pleasing them with their very absurdity and falsehood? May they not thence learn to reject all books which substitute the useful and the true, for the fanciful and entertaining nonsense to which they have become accustomed?

Every teacher must have discovered that there are very few, even among the best of reading-books, though abounding with juvenile stories, the morality of which may be unexceptionable, which prompt the child *to think*, and inspire him with the *love of thinking*. And yet this should be the tendency of every reading lesson, whether small or great. Unless a child *thinks* while reading, he will never *understand* what he reads. Nor will he ever *love to think* on what he

reads, unless the lessons in the book are *beautifully true.* Such they will be, if they are true to nature, for nature is beautiful to a child. It is when every lesson opens to the mind some new truth in nature or art, exemplified by some beautiful illustration drawn from familiar objects, that the curiosity of children is awakened and gratified, and the love of knowledge for its own sake becomes a part of their being, as it is an instinct of their nature, when cultivated, not repressed.

The construction of the easy and simple lessons of this book is such, that no catechetical questions are appended, for the reason that they are uncalled for. The teacher has only to pause after each lesson has been read, and inquire what has been its subject, and examine the child upon the meaning of every sentence or paragraph, to ascertain how far he has been thinking, and to what extent he loves to think.

In many of the lessons, as in that upon "the forms of objects," it is recommended that the diagrams be transferred to the black board, and that they be imitated upon the slates. So also models or specimens, like those in the apparatus of Mr. Holbrook, of New York, will be found of great practical benefit.

In this way, this little book, containing, as its name imports, the "Rudiments of Knowledge," will be instrumental in awakening the young mind to the habit of thinking on every subject about which they read, and prompt them to reject every book which does not afford them the luxury of thought. That such may be its fruits in our common schools is the desire of

THE AMERICAN EDITOR.

N. B. In the order of time, this book should precede the volume entitled "Information on Common Things," and both should be read and studied, before the scientific series is commenced.

PREFACE.

The curiosity of young persons is necessarily first excited by the things which lie most immediately around them, and the circumstances and procedure of familiar life. These are the subjects of their earliest inquiries, and it is extremely desirable that clear, distinct, and correct explanations of them should be invariably given. Most parents of intelligent and well-regulated minds take care that such should be the nature of the answers given to the first inquiries of children; but it is needless to point out, that many persons who have children under their care, either possess not the ability, or have not the necessary leisure, or will not be at the pains, to give correct and satisfactory answers. It occurred to the Editors of this Educational Course, that the best means of ensuring that familiar things should be clearly explained to children, was to render them the subject of an early Reading-Book for school, in which they should be presented in order, and with a careful regard to the powers of young understandings. The present volume is consequently presented to the world, as an attempt to supply this desideratum. It is to be observed, that it aims strictly at an explanation of *external appearances* in the natural and social world. *Principles* are left to be adverted to for the first time, in the volume which succeeds in the Educational Course—entitled "An Introduction to the Sciences."

Although very great pains have been taken, in this little volume, to express ideas in the most simple language, it has been found absolutely unavoidable in many cases to use

words by no means familiar to young persons. It is expected, however, that the teacher will more than neutralize the difficulty thus occasioned, by the exercises to which he will subject the pupils on the meaning of words, according to the usual forms of the intellectual mode of instruction. A graver difficulty may be found in the nature of some of the subjects, as Government, the Faculties and Emotions of the Mind, &c. But here, also, the teacher must do his best to help out the ends of the compiler, giving all the additional explanation, and all the subordinate illustration, which he may have at command, or which may appear to him necessary. He will discover that there is scarcely a sentence in the volume which a person of ordinary intelligence may not greatly amplify, to the unspeakable advantage of the young learner.

THE

RUDIMENTS OF KNOWLEDGE,

IN

COMMON THINGS.

INTRODUCTORY LESSON.

[My first lessons at school were in learning my letters. And when I knew them all, and could call their names, both backward and forward, and whenever I saw any one of them by itself, I had then got through the *alphabet*, as the whole of the letters are called.

But I found it very hard to learn my letters at first, and it took me a long time to know them all, so that I could make them in the sand, or draw them on my slate. And after I had got through one alphabet, I had to learn another; and the letters were not all alike even when called by the same name. There is big A and little a;—big B and little b;—and so of the rest. Well, by and by I had learned to know all the big letters, and all the little letters, but I was not done with the alphabet yet, for I then was told which were *capital* letters, and the difference between *Roman* letters, and *Italic* letters.

All this I had to go over a great many times, before I could know it all. But I am not sorry that so much pains was taken in learning letters, since all the books in the world are composed of letters, for I have already learned that *letters* make *syllables*, and these syllables are joined

together to make *words*, and words are so arranged as to make *sentences*, and these sentences are formed into *paragraphs*, which are spread out into *pages*, and these into books containing a great many pages and leaves.

Now, when I ask a great many questions of my parents and teachers, they sometimes answer me by saying, "My child, *Read and you will know*." And as I have been taught to spell and read, I find that I must also learn the *meaning* of words, in order to understand what I read, and all this I am learning in my spelling books, which give me the definitions of words. So also I have a Dictionary which I can turn to whenever I find a hard word, of which I do not know the meaning. It is thus that I am able to read books and to understand them. And I can now know the reason why so many little boys and girls are so ignorant of every thing around them; for they do not know how to read, and I am very sorry that so many children are growing up without going to school, and very many of them do not even know their letters. But, as I have been so favoured, I wish to gain all the knowledge I can, and therefore I love good books, and spend much of my time in reading them. This makes me more happy than I should be, in idle and trifling plays, which not only waste my precious time, but are often dangerous to my health and limbs, and might bring me into bad habits, and into bad company too. And since I have learned to love books, I am never lonesome, for I find pleasant employment in reading, and thinking about what I read, by which means I am learning something new and useful every day. For my books are not only filled with letters, and syllables, and words, but they give me information about men and things, which I can only learn to know by reading. The more I read, the more I may know, and the more I know the more happy and useful I may be, if I improve all my knowledge for good purposes.

But I am a child, and do not know the meaning of many *things* which I see. When I look around me, I see all kinds of things, which I should like to be informed about. I see the sky over my head, and the ground on which I walk. I also see that some things are without

life or motion, and that they lie where they are placed. I see that other things have life, and that they are able to move about from place to place. All this seems strange to me. But I am a scholar, and will listen to the instruction which my parents and my teacher give me. I will also try to read this book, which will explain the meaning of many things that I see, and which it is proper for a young person to know.

OF GOD AND THE WORKS OF CREATION.

All the things which we see are called objects. Objects are of three kinds. The first kind are those which have life, and can move about in all directions, wherever they have a wish to be, and are called *animals*, or living creatures. The second kind of objects are things which grow in the earth, as flowers, grass, and trees, and are called *vegetables*. The third kind of objects are those which have no life whatever; as the sky, the earth, stones, water, houses, furniture, clothes, and other articles. All these are called *inanimate objects*, and they are unable to move from the place where they are put.

All things have been made by our Heavenly Father, who is called God. In the beginning He made all things, both the objects which are inanimate, and those which have life. He made the sun, the moon, the stars, the earth or world on which we live, the sea, the herbs and trees, and all the animals which live on the land, in the air, or in the water. God is, therefore, called the Creator, which means the maker of all things, and His works are called the Works of Creation.

God is a spirit, and is invisible. Though He cannot be seen, He is everywhere, and is able to see all that we do, and know all that we think. God is also good and just in all his ways. He provides food for all living creatures. It is our duty to love God, and to pray to Him, and thank him for all his mercies.

Let us do no ill, so that God may love us, and take us into his holy keeping. The Bible is the word of God, which has been given to us for our instruction; and if we

read and study it with an humble heart, we shall learn what have been the works of the great Creator, and how kind He has been to the children of men.

OF ANIMATED CREATURES.

All living creatures are animals. They live by breathing air, and by eating food with their mouths. Their food gives nourishment to their bodies; and if they could not get food, they would soon die of hunger. Most animals have senses, by which they can see, hear, smell, taste, and feel, or touch.

A doll has eyes, but it cannot see, neither can it use any other senses, because it is an inanimate object, and has no life. Life has been given to animals by God our Heavenly Father, and He only can give life. A man can make a doll with a face and eyes, and he can dress it with fine clothes, but he cannot give the doll life. It remains only an inanimate object, without sense or power of moving.

There are many different kinds of animals, both large and small, in all parts of the earth, some of which live on land, and others live only in water. The chief of the animal creation is *Man*, beneath whom all the lower animals are placed, so that no one can rise equal to him in rank or power.

Beasts are animals covered with skins of hair, wool, and fur, and they walk upon four legs on the ground. Horses, cows, dogs, sheep, cats, and many other animals of this class, are beasts. Animals are also called *quadrupeds*, because they have four feet. Some beasts have feet of a single hoof, like the horse; others have feet with the hoof cloven into two, like the cow, the sheep, the pig, and the goat; and others have feet with toes and claws, like the dog, the cat, the tiger and other creatures. The ox and the sheep are quadrupeds, which are killed by mankind for meat or food; their skins are made into leather for shoes, their bones are made into buttons, and knife handles; the horns are used for making combs; the hoofs for making glue, and the feet for making neat's foot oil, while their fat furnishes us with tallow for making candles, and the wool

of the sheep is cut off and twisted into threads, and the threads are woven into fine soft clothing. The process begins with washing and then shearing the sheep, when the wool requires still farther cleansing, sorting, oiling and carding, when it is spun, reeled and wove, and afterwards scoured and cleansed for the dyer; but certain cloths are dyed in the wool before spinning it. Cashmere shawls and camblets are not made of wool, but of the hair of a species of goat. Wool is manufactured into cloths in various countries, but in England and America the best cloths are now made. The number of sheep in the United States is estimated at 20 millions, and 45 millions of pounds of wool are yielded annually.

Birds are a very pretty kind of animals. They are covered with feathers, and have two wings on their sides, with which they can fly in the air, and go very great distances without being tired; they have also two legs and feet, with which they can walk on the ground, or stand on branches of trees. Some birds are very small, such as sparrows, and linnets, and wrens, and robin-redbreasts, and canaries, which build neat little nests of moss and other things, in trees and bushes, or cages, to live in. Pigeons, and rooks, and crows, are birds of a larger size; and so also are hens, and turkeys, which we see walking about and picking up seeds. Ducks and geese are birds which love to swim in water, and they have two web-feet, with which they push themselves along in swimming. All birds lay eggs in their nests, and the young birds come out of the eggs, after they have been sat upon some time and warmed by the old birds. This is called *hatching*.

Fishes are animals that live altogether in water. They have skins with smooth shining scales, and they have fins on their sides, with which they keep themselves up in the water. Fishes can also swim forward very fast, and dart through the water after flies, or any thing else they would wish to eat. Some fishes are very large, much larger than a man; but others are small, such as herrings; and they swim in great numbers in the sea and in rivers.

There is another class of animals called *reptiles*, but we do not see many of them in this country. Reptiles, such

as snakes, vipers, and adders, have clear shining skins, like fishes, and they crawl with their bodies on the ground among the tall grass of meadows and in marshes. Some reptiles, such as the frog and toad, have feet, with which they can walk or leap forward. The frog is a very pretty reptile, which leaps, and is often seen in meadows or beside pools of water. We should not pelt frogs or toads with stones, or otherwise hurt them, for they are innocent creatures, and suffer as much from being pelted as we could do.

Insects are another class of animals, of which there are great numbers in this and other countries. Flies, gnats, bees, and butterflies, are insects which we see flying about in the fine summer weather, and sometimes they are very troublesome to us. But although insects are sometimes troublesome, they are very useful, because they are food to birds and fishes, and do other good services in creation. Therefore we should never kill flies, or hurt insects, by cruelly pulling off their legs and wings as naughty children do who are hard-hearted and unfeeling.

One of the most interesting and useful of insects is the silk worm, which is a kind of caterpillar, which changes into a butterfly whose eggs yield young worms. These, after feeding for a time upon the leaves of mulberry trees, spin for themselves cones or cocoons about the size of nutmegs, which are filled with fine silken thread, which is the source of all the silk, satin, and velvet in the world, all being first spun by the silk-worm and then wove. Silk then is an animal product, and is yielded by a little insect, not two inches long, by whose ingenuity alone we are supplied with the material of our finest and richest clothing.

So also the bee is an insect, found in various countries, and is the source of all the honey in the world. In many countries they are wild, and make their honey in hollow trees or in the clefts of rocks, from which people gather it to supply other countries where there are no bees. In America the bees are swarmed in hives, in the sides of which a little window is often placed, so that we may see the bees at their work. Honey is very good to eat, and mead is made out of it. But the wax of which the cells

of the honey-comb are constructed, is also made by bees, and is hence called beeswax. It is yellow as we usually see it, but by bleaching it becomes white, and is then used for making wax candles, and also imitations of flowers, fruits, &c.

Besides these classes, there are many kinds of animals so small that they cannot be seen by the eye, but which exist, and enjoy themselves according to their nature, in water and other substances. The whole of creation swarms with living creatures, large and small, and all designed to serve some purpose, though in many cases we are quite unable to tell what that purpose is. The most bountiful provision has been made by their Creator for the daily food of all the animals that exist. The greater number live by eating the herbage of the fields and plants, and also the small seeds and fruits of trees. Others live by killing and eating creatures which are smaller and weaker than themselves, and which, if not thus destroyed, would become too numerous and troublesome.

Some of the larger quadrupeds, as the lion, the tiger, and the wolf are beasts of prey, and live by chasing and killing sheep, or any other animals that cannot defend themselves. A few animals, such as the horse, the cow, the ass, the dog, and the cat, are fond of living under the charge of mankind, and taking what food is given to them. These are called *domestic animals*, and are of great use to us; they should be treated with much kindness for their docility and their services.

Many of these are very useful to man, and would be esteemed as of greater value, if we were to be deprived of them for a time, by any cause. What should we do if there were no cows in our country to give us milk? Beside the various nice articles of food prepared from milk, and its use as a nourishing drink, it is from milk and the cream found in it, that all our butter and cheese is made. So that the cow is justly considered the most useful of all animals, and especially when we remember that after she is dead her flesh is good for food, and her hide, and horns, and bones, and hoofs, and fat are all good for different purposes, as has been already explained on page 10.

But the horse is little less useful, to ride under the saddle, or drive, in harness before carriages, wagons, and ploughs, drawing heavy burdens, and often at great speed. Horse power was formerly much used in propelling boats, and the engines of mills and factories, though in modern times, the power of steam is generally substituted. But still we should find it a sad loss if we were deprived of horses, so useful are they in travelling, and in many kinds of labour.

Dogs are very useful animals, in guarding the house by night, and they are often employed by sportsmen in finding and running down game, and in swimming and diving after water fowl. Some kinds of dogs will catch rats and mice, while others may be taught to carry burdens, and deliver messages, in which they often show great sagacity. They have sometimes been harnessed in little wagons and sleighs, indeed in some countries dogs are large and strong enough to be used in the place of horses. Dogs of all kinds are remarkable for their affection for those who feed them, and often show their gratitude for kindness shown them by wonderful efforts in time of danger. Little children and even grown people have often been saved from drowning by dogs swimming to them and bringing them to the shore.

But in hot weather, dogs are dangerous companions, because they become sick sometimes, and lose their senses, by madness. In this state they do not know their best friends, but will bite every one that comes in their way, and the bite of a mad dog is almost always incurable, destroying human life in a few hours. It is an act of mercy to the dog as well as to our fellow creatures to kill mad dogs. But it is very cruel to do, as they often do in large cities, to kill all the dogs, for fear some of them may grow mad, and yet there is so much danger that it is thought to be necessary for the public safety.

Cats are very useful in a house to destroy rats and mice, and when they have little kittens it is very naughty to kill or drown the young cats, as many people do to get rid of them. It is better to leave them in the garret with their mother until they are old enough to take care of themselves, and then give them to the neighbours who have no cats.

Rabbits, squirrels, and birds of various kinds are also kept as domestic animals for the amusement of the children in many families, and we should always feed them well, and supply them with water and other things suited to their nature. Good boys and girls are always kind to such little pets, and love them very much, while they are loved by them in return for their kind offices.

We should try to learn the nature and the names of animals, and how they are divided into classes and species. We should also never call any animal by a wrong name, but give every one the proper name that belongs to it. Some persons call a fly a beast, but it is not a beast; it is an insect. All animals with four feet are quadrupeds. A bird is not a quadruped, because it has only two feet, and it is therefore a *biped*. For the same reason we are bipeds.

For want of a knowledge of the nature and the proper uses of animals, some persons have held certain animals to be *sacred*, or worthy of great respect, and of being bowed down to and worshipped. These persons have also held other animals in such great abhorrence, that they would not touch them, or be kind to them. All this is very wrong. All animals are equally good in the sight of God, and should be the same in the sight of man. There are, indeed, no distinctions of rank among animals. The lion is sometimes called the *king of the beasts;* but this is only because he is a very powerful animal. The lion is no better than other beasts; and he is not so useful to mankind, or deserving of so much care, as the laborious and patient ass.

[In the course of the above lesson the teacher may show pictures of animals, and mention a few leading points in their character. It is, however, too early to define the scientific classification of animals; that forms a department in the more advanced work, "THE INTRODUCTION TO THE SCIENCES."]

OF MANKIND.

Mankind are the *human species*, to which we belong, and they are above all the lower animals in power and wisdom. Mankind are also called *people*, and children are young people. A father and a mother with their children form a *family*. Mankind are beings with *reason*, or minds to think, and they are able to rule over all kinds of beasts, birds, or other creatures. They do not walk like beasts, but stand upright upon two feet, and they have arms with hands and fingers, with which they can do any work that they wish to do. They have not skins with wool or fur upon them. Their skins are naked, and they require to have clothes to cover them; but they are able to make clothes with their hands, and to use *tools*, with which they can build houses and make furniture, and do all other things that are useful. They can, likewise, kindle fires for cooking their food, and for warming themselves when cold.

Mankind do not like to live alone. They are fond of living in families, or with other persons, and also to have neighbours in *houses*, near them. Some people live in the country in farm houses and *cottages*, but most people live in houses near each other in *villages*, *towns*, and *cities*. A village is a small number of houses standing together. A town is a large number of houses standing together, with the houses placed side by side in rows or streets. A city is a very large town, containing a great number of people. The city where the head of the government resides, is the *capital* of the country. London is the capital of England. Washington is the capital of the United States. In America every state has a capital, where the governor resides and the laws are made. Harrisburg is the capital of Pennsylvania, and Albany is the capital of New York. The building in which the legislature meets in the capital, is called the Capitol. The house of a king, or of a prince, is called a palace.

The reason for people living together in towns and

cities, is, that they may assist each other, and enjoy the pleasure of seeing and speaking to each other. This is called being *social*, or living together in *society*. All the people that live together in a country are its inhabitants, and they form a *nation*. There are many countries and nations in the world.

Every person has two names, one of which is his *surname*, and the other his *Christian* name. The surname is the principal name, being that of the family to which the person belongs. The Christian name is that which has been given at baptism, and is always put first. If a person be called John Adams, John is the Christian name, and Adams the surname. I can tell what are my Christian and surname. Every boy and girl can tell, because they have been informed by their fathers and mothers. Some people have one or more *middle* names, which they write between their Christian names and surnames, as John Quincy Adams, or Ann Maria Smith.

All people have likewise a national name, by which they are known from people of other nations. We get a national name by being *natives* of a country, or being born in it. If we be born in England, we are called *English;* if in Scotland, we are *Scotch;* if in Ireland, we are *Irish;* if in France, we are *French;* if in America, we are *Americans;* and so on with every nation and people.

Some people have white skins, with blue or grey eyes, and light hair on their heads. Other people have dark skins, with black eyes and black hair. But all people are human beings, and are "made of one blood;" and it is no matter what is the colour of their skins, or their outward appearance. We should never hate or ill use any persons because the colour of their skins is different from ours, or because their outward appearance is not beautiful, but be equally kind to all.

One of our hands is the *right* hand, and the other is the *left*. All boys and girls learn which is their right hand. It is that with which we shake hands, and is more used than the left. We have, also, a right and a left foot, and a right and a left eye, and a right and a left side. The left side is that on which we feel our heart beating. Every

one knows what is meant when they are told to stand on the right or the left of a person; they go to his right or his left hand. It is a mark of honour and respect to be set at the right hand.

Animals rest and *sleep* when they are tired. When they sleep, they lie down and shut their eyes; and when sleeping, they enjoy rest. Some animals, however, such as the horse, can sleep standing; and some others, such as the hare, can sleep with their eyes open. The proper time for sleeping is in the night, when it is dark. When we sleep, we sometimes *dream;* but dreams are only idle fancies passing through the mind, and do not mean any thing. When animals are not sleeping, they are *awake.*

All animals, except man, eat their food in a *raw* state. The ox and sheep crop the green herbage of the fields just as it grows, and beasts of prey devour at once the flesh of the animals they kill. Birds, likewise, catch little flies while on the wing, and swallow them in a moment. Mankind cannot live on fresh vegetables, or raw food of any kind. They can eat only a little ripe fruit, or certain ripe vegetables, without being hurt by them. All their ordinary food has to be dressed at the fire; and when it is properly cooked, it is pleasant to the taste and nourishing to the body.

Mankind *cook* and eat the flesh of oxen, which is called *beef;* the flesh of calves, which is called *veal;* the flesh of sheep, which is called *mutton;* the flesh of swine, which is called *pork;* or when this is smoked it is called *bacon;* and also the flesh of hares, rabbits, ducks, geese, turkeys, chickens, pigeons, partridges, and other creatures. Mankind likewise cook and eat fish. The chief article of our food is bread, which is prepared from the flour of wheat, or other grain. We pray to God, that he may give us our "daily bread," which signifies our means of daily subsistence.

When animals are well, and are able to go about and take their food, they are said to be in *health.* Sometimes they are so ill that they cannot walk or take any of their usual food, and then they are in *bad health.* Mankind are most liable to be ill; diseases affect them, and they are

sick. Physicians try to make them well, by giving them medicines; we should, therefore, never refuse any medicines that are offered to us when we are ill, for it is by that means that we may be made well.

Some animals live a long time, and others live but a very short time. Dogs are known to live till they are fourteen or fifteen years old, when they die; and some horses live till they are twenty years old. But little birds live only a few years, and most insects do not live more than one year. Some insects live only a single hour. The smallest kind of gnats sport for a short space of time in the beams of the sun, and then drop down, and are seen no more.

All animals are male and female, and have young animals like themselves, and these they leave behind them at their death. The young grow old in their turn, and then leave their young to come after them. This is called the following of one *generation* after another. Human beings live longer than most other animals. Some men and women live till they are above seventy years of age, but many die from illnesses when they are infants. The young people that are now at school and growing up, will perhaps live to be old people like their fathers and mothers, and grandfathers and grandmothers; but they will not live for ever. All must die, and leave room for new generations.

When a body is dead, all its life is gone. It cannot see, or feel, or move; it is an inanimate object, and is so unpleasing to look upon, that it is buried in the ground, where it rots into dust, and is no more seen on earth. But although the bodies of mankind die and are buried, they have *souls*, which live for ever, and which are given up to the God who gave them. It is proper that we should live so purely that we may not be afraid to die, or to yield our souls at death to our Heavenly maker.

Mankind are called *rational* or *reasoning beings*, in consequence of having minds to reflect on what they see and do. They are also called *responsible* or *accountable beings*, because they have souls, which are accountable to God for actions done during life. But none of the lower animals are rational or accountable beings. They have not souls to be accountable, nor minds capable of thinking. They do

not know right from wrong. When a beast dies it perishes for ever, so far as we know.

Human beings are very ignorant when they are young, and before they are taught the meaning of what they see. They do not know how large the world is, or what is its shape. They think that the world is flat, like a table, but they learn that it is round like a ball. It is only by having been told, that they know their own name, or their right hand from their left. Children, being so very ignorant of all things, are sent to school to be instructed, and the more that they are taught, the more happy are they likely to be when they grow up. If we were not all ignorant by nature, we should have no need of teachers, or books, and it is only by respecting our teachers, and loving our books that any of us can become wise.

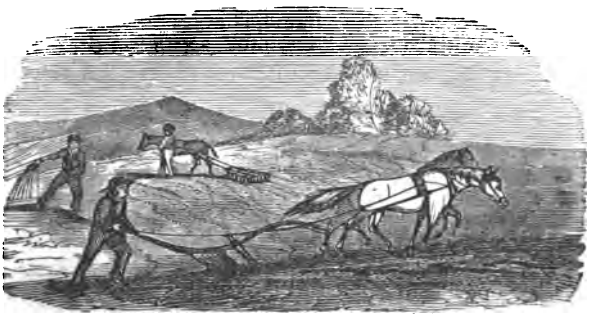
THE COUNTRY—PROCESSES OF HUSBANDRY—VEGETATION.

When we walk into the fields in a fine summer day, we see many things that are very beautiful, and pleasing to behold. We see the fresh green grass growing in the meadows, mixed with clover and other herbage, with the cows feeding upon them. We see fine large trees and bushes covered with leaves, and hear birds singing merrily on the boughs, and chirping to the young birds in their little nests. We also see the glorious sun shining in all his splendour, giving light and heat to the face of nature, and glancing on all kinds of flowers. Perhaps, also, we may see flocks of white sheep feeding on the sweet pastures, with their lambs frisking beside them, and shepherds with their dogs watching the flocks, that they may not go astray.

These are only a few of the things which are to be seen in the country, for the country is very large, and spreads away in *plains*, *valleys* and *hills*. It also contains *springs* of water, and *rivers* running through the valleys. In some hollow places, there are *lakes*, which are large sheets of water; and in other places, there are marshes and meadows with small ponds in them. Some lofty hills, which rise from the plains, are called *mountains*. There are *rocks* in

the inside of hills and mountains, and also below the level ground.

It is in the country that most of the food that we eat is produced. The fields are first ploughed or dug up in furrows, by a *plough*, which is a machine drawn by horses, and guided in even rows by a man who holds it. The



business of a *ploughman* is very healthy and pleasant, for the ploughman breathes fresh air all day long, and sometimes he is so merry that he whistles or sings, as he drives his team of horses over the fields.

After the fields are ploughed, another man called a *sower*, goes forth with a large quantity of corn or grain; and he sows the corn by scattering it with his hand among the open furrows. This is called putting *seed* in the ground. After the sowing has been done, another man comes with a *harrow*, which is a rugged flat machine with teeth on its lower side, drawn by a horse; and the harrow being dragged over all parts of the field, the earth is covered in over the seed in the furrow, and then the seed is in a condition to grow, and produce more corn.

After all these things have been done, the rain falls on the earth, and sinks down to the seed, which it softens and causes to *sprout*. At first, each seed has but a small sprout, but the sprout is quickened by the heat of the sun, and soon shoots above the earth, like a blade of green grass. It then grows tall, with an ear of corn at the top, and the sun

ripens it and makes it yellow. It is now ready to be cut down; and so, in *harvest*, all that is ripe is cut by reapers, some with scythes, and some with sickles. Corn is sown in the *Spring* season; it grows tall in *Summer*, when the sun is powerful; and is cut down in *Autumn*. After Autumn the fields are bare, and the *Winter*, which comes next, is so very cold that few things grow.

The time of harvest in autumn, is a pleasant, happy time. Here is a picture of two reapers cutting a field of corn. See how active they are, stooping with their sickles, and cutting

bunches of the stalks. See, also, how a man behind them is binding the sheaves, and a cart is going loaded with the sheaves to the barn-yard of the farmer. The barn-yard is near the farm-house among the trees.

Wheat, and rye, and oats, and barley, are called *corn*, and are all reaped in this way. After the corn has been taken to the barn-yard, and the ears have been thrashed to loosen the grains from the straw, the grains are ground in a mill, and become flour or meal, which is made into bread for us to eat.

Here is a pretty little poem on the flowers which we can gather in Autumn, when the reapers are busy in the fields.

HARVEST-FIELD FLOWERS.—BY MARY HOWITT.

Come down into the harvest-fields,
  This autumn morn with me;
For in the pleasant autumn fields
  There's much to hear and see.
On yellow slopes of waving corn
  The autumn sun shines clearly;
And 'tis joy to walk, on days like this,
  Among the bearded barley.

Within the sunny harvest-fields
  We'll gather flowers enow;
The poppy red and the marigold,
  The bugles brightly blue;
We'll gather the white convolvulus,
  That opes in the morning early;
With a cluster of nuts, an ear of wheat,
  And an ear of the bearded barley.

Bright over the golden fields of corn
  Doth shine the Autumn sky;
So let's be merry while we may,
  For time goes hurrying by.
They take the sickle from the wall
  When morning dews shine pearly;
And the mower whets the ringing scythe,
  To cut the bearded barley.

Come, then, into the harvest-fields;
  The robin sings his song;
The corn stands yellow on the hills,
  And the Autumn stays not long.
They'll carry the sheaves of corn away,
  They reaped to-day so early,
Along the lanes, with a rustling sound,
  Their loads of the bearded barley!

There are many other things which grow in the fields for the food of man, besides corn. Potatoes are planted in

rows in the fields, and after they have grown, the young potatoes are found at the roots; they are then dug up from the earth, and carried away for use. Turnips are sown in the ground as seed; and each seed, though only the size of a small pin-head, grows to be very large. Peas and beans are also sown in fields and in gardens, and the young peas and beans grow in pods on the tops and sides of the stalks. The pods are shells, in which the young peas and beans lie in even rows. Apples, and peaches, and pears, and cherries, are *fruits;* and they grow on trees in gardens and in orchards. Oranges and grapes are also fruits; but they grow in warm countries. Blackberries, raspberries, gooseberries and currants are very good small fruits, which grow on bushes. The bushes have often sharp prickles on the branches, and we must take care not to hurt ourselves when we pluck the fruit. Strawberries grow on little vines which creep along the ground and are a delicious fruit. Grapes are found on large vines, which spread over arbors, or summer houses, and hang in large bunches from among the leaves.

All things that grow in the earth, in fields, gardens, and by the sides of pools, and every where else, are called *vegetables*, and the act of growing is termed *vegetation.* Vegetables are said to be *alive* when they are growing, and *dead* when they wither and cease to grow. But vegetables cannot remove from one place to another like animals. They must stay in the place where they are growing. Some people, however, plant pretty flowers in flower pots; and then they can lift the pots, with the flowers in them, from one place to another, sometimes letting them stand in rooms, and at other times putting them on the outsides of windows, so that the sun may shine upon them.

Vegetables grow by drawing up sap from the ground through the roots, and the sap rises from the roots to the stem of the plant, and then through all the branches. Unless, however, they had the heat of the sun, vegetables could not grow. When the bleak cold days of Winter come, the sap goes down again into the earth, or helps to increase the bulk of the plant, the leaves wither and die, and the plants are bare till the warmth of Spring again revives them, and

causes them to push forth new buds and leaves. All vegetables yield seed after their kind, and with this seed, young vegetables may be raised. There are new generations of vegetables, like new generations of animals, and one follows in succession after the other.

[Many plants and vegetables are of great importance to mankind, furnishing not only food but clothing, and very many of the comforts and even luxuries of life. For example, we are all familiar with muslin, cambric, calico, and the variety of cotton goods of which so much use is made. The cotton of which these are made is the product of a plant which grows abundantly in many warm countries, and nowhere more luxuriantly than in the southern portions of the United States. It is found in the fruit or pods of the cotton plant, which is six feet or more in height, and forms a staple article of commerce yielding to the producers great wealth. The fields of cotton in general are cultivated by the labour of African slaves, whose lives are early sacrificed by the unhealthiness of the climate. Immense quantities of cotton are however exported from the United States to foreign countries, beside the vast amount consumed in our own factories, where it is spun and manufactured into cloths, by machinery propelled either by water or steam.

Flax is produced by a plant extensively cultivated in various countries, and very common in many parts of America. It has a long slender stem full of leaves, and a small blue flower which yields the flax seed or linseed, from which the oil is extracted. The fibrous parts of the plant are subjected to certain processes which separate the *tow* or coarser portion, out of which tow cloth is made, from the finer parts, which are then known as *dressed flax*, and out of which linens, and the finest cambrics are manufactured. In its natural state, flax is of a dark brown colour, but is bleached at the factories after it is spun and wove.

Hemp is a somewhat similar plant, though its fibres are stronger, and it is hence used for making ropes, cables, sail cloth; and the best Russia sheetings are also manufactured out of hemp. Other very durable materials for cloth are found in some countries, such as grass, and the

bark of trees, &c., there being other examples of the product of organization employed in clothing.

Sugar is the product of the sugar cane, of the maple tree, of the beet root, and a variety of other vegetables. *Coffee* is the berry of a foreign plant, cultivated to great extent in many tropical countries, and which is used in Europe and America in immense quantities, being a daily beverage of the entire population. It is a native of Arabia, but grows in the East and West Indies, South America, and Africa in great abundance. The tea plant of China has also become an article of universal use throughout the civilized world, and like coffee is regarded among the necessaries of life. These are a few only of the products of vegetation, which are sources of wealth to different countries, and are important articles of commerce.]

INANIMATE OBJECTS—STONES, SLATE, GLASS, CLAY, BRICKS, METALS.

The streets are paved with *stones*, and many houses and walls are built with stones. Most of the stones which we see are dug from the ground. The earth is opened, and then rocks are found beneath, in large masses, and of different kinds. The stones are pieces of the rocks broken away with hammers, and shaped into the sizes that are wanted. The place where stones are dug from the rocks, is called a *quarry*.

Some stones are hard and solid, and others are soft and brittle. Those which are hard and solid are the best for building, because they last longest. Soft stones are melted down by water washing upon them, and their particles form sand. There are beautiful shining sands on the sea-shore, which have been washed from rocks. Most stones are opaque, or so dull that you cannot see through them; but some stones are transparent and sparkling, and you can see through them as if they were glass. *Slate* is a kind of blue stone, found in layers, and cut in small thin pieces for putting on the roofs of houses. When polished, the pieces can be made into school-slates.

Glass is a clear smooth substance, made of sand melted by a strong heat, and the ashes of certain plants. When hot, it is soft, and is easily made into a flat sheet; and when the sheet is cool it is glass. Small pieces are cut from the sheets of glass to make panes for windows. Glass is a fine transparent substance, very brittle, or easily broken. Boys should be careful not to break the glass in windows, for it is very dear. But if they break it by accident they should always tell that it was they who did it, and then that will save others from being blamed. Crystal is a fine kind of glass.

Clay is a fine soft substance found in the earth, which is formed into jugs, basins, plates, and other articles. But these are not ready for use till they have been baked with a fire, and glazed to make them smooth on the surface. When finished, they are called *earthen-ware*. *China* is a fine kind of earthen-ware, made from ground flints. Flower-pots are brown unglazed earthen-ware. We cannot see through earthen-ware as we see through glass, because it is opaque. Most objects or substances are opaque.

Bricks are also made of clay. The clay is moulded into the form of bricks, and then burnt with fire in a large kiln. After the bricks are cooled, they are carried away to build houses and walls. Bricks are not so hard as stone, but they are much used for building where stone is difficult to be got. London, Dublin, Manchester, Liverpool, and other large towns in England and Ireland, are built of brick. So also most of the houses in the large cities of the United States of America, are built with brick. Brick is little used in Scotland, because stone is very plentiful in that country. The red tiles for the roofs of houses are made of the same kind of clay as bricks.

Many useful things which we see are made of *metal*, of which there are different kinds. Metals are found among rocks, usually mixed with earth and rocky substances. They are then called *ores*. The ores are put into furnaces, and the metal then comes out pure. When cool it is ready for use. Metals are hard, but not so hard as stones; some of them are also malleable, which means that they can be beaten out into thin pieces by hammers, without being

broken. Some are softer and more malleable than others; and they are all very heavy. The principal metals are Gold, Silver, Iron, Copper, Lead, and Tin.

Gold is a yellow metal, and is very scarce and dear. It is made into money, also into rings for wearing on the fingers, and other trinkets. *Silver* is a fine white metal, which is also made into money, but is not so valuable as gold. *Iron* is the most useful of all the metals. It is made into stoves, nails, locks, hinges, hammers, axes, and all other tools. Pots, kettles, and other vessels for cooking, are also chiefly made from iron. Iron, when made very hard, is called *steel*, and is made into knives, needles, and other things. *Copper* is brown, and is made into pennies or cents, also into large sheets for various purposes. *Lead* is light blue in colour, and is softer than the other metals. It is made into pipes and cisterns for water, and many other articles. *Tin* is of a light colour, but harder than lead. It is very useful for covering the insides of cooking utensils.

Some articles are made from two metals mixed together when they are melted and hot. *Brass* is a very pretty light yellow metal, made from a mixture of copper and zinc. A great number of ornaments for furniture are made of brass. Bells are also made of a mixture of copper and tin, but chiefly copper. Some bells are very small, for hanging in houses, and are pulled with wires to warn servants that they are wanted. Other bells are very large, and are as tall as a man. These large bells are hung in steeples of churches, and they are rung to warn people that it is time to go to church. Bells are also rung to call children to school, and to let workmen know that it is time for them to go to work. Some bells have a brisk sound; but large bells give a loud sound, which is heard at a great distance. We can also cause glass cups to make a sound when we strike them; but if we strike too hard, we shall break them. Bells are not so brittle as glass; they are tough or pliable, and do not break when they are rung. Lead and tin mixed, form *pewter*, with which spoons, dishes, and many other articles, are made.

[*Coal.* Mineral or pit coal is dug from mines, which are

numerous and extensive in various parts of the world, particularly in Great Britain and in America, and being found below the surface of the earth is generally classed among minerals, although there can be no doubt that it originated from vegetables, and is the remains of burned trees and plants by subterranean fires. Still it is called mineral coal, to distinguish it from charcoal. There are two principal kinds, differing in their nature and composition somewhat, and designated as anthracite and bituminous. The former is harder, and burns without much flame or smoke, but the latter abounds in sulphur, and gives out both flame and smoke. It is very extensively used as fuel, and is of immense importance to all our manufactures in which heat is necessary, as in furnaces, steam engines, &c. Charcoal is made by burning wood in furnaces from which the air is excluded after it is completely on fire. It is used for kindling fires from its ready combustion, but it is chiefly consumed in the manufacture of gunpowder, which, besides serving the purposes of war by sea and land, is used for blasting rocks and various other useful purposes. Charcoal is valuable in many of the arts, and is useful for preserving fresh meats and removing putridity from water and other substances of food and drink.]

[In the above lesson only the principal kinds of inanimate objects are mentioned. It is presumed that the pupil has been instructed in the nature of most objects of a simple kind at the Infant School; but if this has not been the case, the teacher can exhibit and explain the qualities of many objects, both natural and artificial, with a view to intellectual exercise. Most schools now possess an extensive collection of objects for the instruction and amusement of pupils.]

WOOD—TREES.

There are many kinds of *wood* or timber, some of a coarse, and others of a fine quality. When trees have grown for a great number of years, and are tall and thick, they are cut down at the root, the branches are lopped off, and the trunks form wood or timber. The wood is next sawn into long deals and beams with saws, and is ready to be made by carpenters into chairs, tables, school forms, the floors of houses, doors, carts, and a vast number of

other things. Fir, ash, elm, beech, and oak, are the most common kinds of wood in Britain; and of these, fir is the commonest, and oak is the strongest. In the United States, white oak is found abundantly, especially in Massachusetts and New Hampshire, and used for ship building. Live oak, chiefly used in our ships of war, is found in Florida and other southern states. The yellow pine of North Carolina is also employed in ship building. The eastern states abound in white pine and spruce, and here as well as in British North America, the business of lumbering is carried on to great extent, immense quantities of timber, boards, and logs, being felled, floated and rafted down to tide water annually for exportation. Mahogany is a very fine wood, which is brought from foreign countries, and is made into beautiful tables, chairs, and other articles.

TREES.

In India there are spicy trees,
  Whose fruit and gorgeous bloom
Give to the faint and languid breeze,
  Its rich and rare perfume.

In Portugal and fertile Spain
  Abound the orange groves;
In France the juicy vines they train
  Around the trim alcoves.

Where South American forests spread,
  And savage Indians roam,
The huge mahogany rears its head
  To deck our British home.

But fruits, and plants, or trees like these,
  Our climate will not suit;
Yet we have many useful trees,
  For timber or for fruit.

The sombre yew-tree often lends
  Its greenness to the grave;
The weeping-willow fondly bends
  Its branches o'er the wave.

The birch displays its slender tress,
  Yet beautifully fair;
The poplar waves its slender dress
  With slightest breath of air.

The elm lifts up a lofty head,
  And first in leaf is seen;
The beech extends an ample shade
  Of leaves of glossy green.

The stately oak, the forest's pride,
  A stem enormous shows;
And, spreading out on every side,
  Gigantic branches throws.

Its leaf is late in spring, yet shares
  The zephyr's gentle sigh;
And late and long in autumn wears
  A deeper, richer dye.

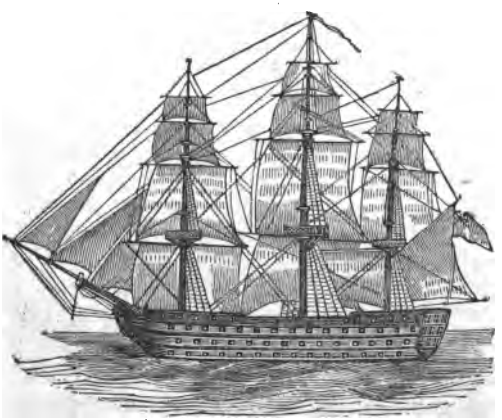
Trees not only furnish savoury fruits; their aspect is delightful, and their shade is refreshing during the heats of summer. Sometimes trees grow singly in fields and gardens, and sometimes a great number of them grow together in plantations and *forests*. There are not many large forests in Britain, because the land has been cleared for cultivation; but in North America there are forests which cover large tracts of country, and they are only now in the course of being cut down. Much of the timber that is used in England, has been brought in ships from North America.

Trees grow, like other vegetables, by the sap rising from the roots through the trunk to the branches. Every tree is clothed with a bark or skin, which is of great use in protecting it from injury, and assisting it in its growth. If the bark of trees be much injured, the trees become weakly, and soon die. It is very wrong, therefore, for any young person to strip, cut, or otherwise injure the bark of trees. They do not know the harm they are doing. I will never do injury to a tree.

WATER—THE OCEAN—SHIPS—RIVERS.

Water is a liquid body. It flows in streams, and can be poured from one vessel to another. A great part of the world, nearly two-thirds, is covered with water, in the form of broad seas, called the Ocean. The water of the ocean is salt, and so bitter that we cannot drink it.

Ships sail on the sea, and they can go from one country to another across the ocean, by the winds blowing their sails, and the pilot guiding them with a *helm* or rudder. Here is a picture of a ship, or vessel, sailing on the sea. It has all its sails set to the breeze, and is going fast along

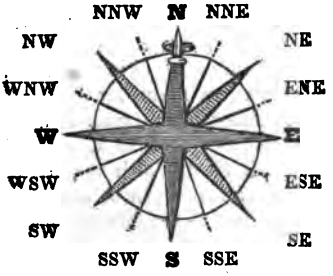


the surface of the deep waters. Some ships have a great number of sailors or mariners in them to manage the sails, and take care that all goes right in the vessel. The person who has the command of a vessel is called the *captain*. It is an awful thing for a vessel to be overtaken by a storm, and dashed upon rocks or sand-banks; then the ship is *wrecked*, and perhaps all the persons on board are drowned.

In modern times, the ocean is navigated by steam-

engines, and vessels of every size are constructed for the purpose of carrying passengers and freight, their motion being by paddle wheels impelled by steam, with or without sails, for traversing the sea, or upon lakes and rivers. They are called steamers, or steam boats.

Mariners guide their vessels across the sea without seeing any land; but they do not lose their way, because they have the *compass* to direct them. The compass is a small object like the face of a watch, with a needle balanced upon it, which always points to the North. Here is a representation of a mariner's compass, with all the points



marked upon it—North, South, East, West, and all the other points between, as N. N. E., which means north-north-east, S. S. W., south-south-west, and so on.

The sun rises in the morning in the east; at mid-day it is south from us; and in the evening it sets in the west. When we stand with our face to the south, our back is towards the north. When a person wishes to go to some place at a distance, he asks in what direction it lies, whether north or south, east or west, and on being told, he proceeds accordingly. In this way, every place in a town, or in a country, can be easily found out.*

In clear nights when the stars are visible, we can see a star very nigh above us at the north, which is called the *North-Star* or Polar Star. In constructing maps, the top is North, the bottom South, the right hand East, and the

* The teacher may here exhibit a small compass, and further explain the nature and utility of the instrument.

left West. Young persons should learn to know the north-star, so that when they are out walking at night, they may understand which is the north. Mariners know the north-star, and they can guide their ships by it; but they do not need to look at it, for they have the compass with them, which tells them which is the north, either by day or by night. If they wish to sail northwards, they go as the needle of the compass points; if they wish to sail southwards, they go in an opposite direction; and so they go in any other direction, always looking at the compass.

A great number of different kinds of fish live in the sea, some swimming about in the water, and others inhabiting shells, which are scattered along the bottom of the ocean, or among rocks on the shores. Fishermen go to sea in boats to catch fish, which they bring to land, and sell to people who wish to have them for food. The fish are caught in nets, a considerable number at a time. The net is let down from the boat, and in a little time pulled up again, bringing with it all the fish that come in its way. Here is a view of three fishermen at sea in a boat, and we see them hauling in their net with a quantity of small fish in it.

All rivers and streams are of fresh water. They rise from springs, and also collect the rain which falls on the ground. After flowing perhaps many miles, they go into

the ocean; but the ocean is never any larger for all the rivers that go into it, for mists or vapours are continually rising from it into the air to form clouds, and that takes away as much water as the ocean gets from rivers. The clouds turn into rain, which falls on the earth, and helps to give water to the rivers.

THE SENSES.

Mankind have five senses, which are of great use to them, and without which they could not know any thing of the world about them. These senses are *seeing*, *hearing*, *smelling*, *tasting*, and *feeling*, or *touch*. We use these senses by means of organs. The word *organ* signifies tool or instrument. The organs of seeing or sight, are the eyes, which are also sometimes called the organs of vision.

The *eye* is a very beautiful clear object, round like a ball, and is set in the head in such a way that we can move it about in its place, so as to look on different sides of us. The eye can only see when there is light. At night, when there is very little light from the moon and stars, it is difficult for the eye to see any thing; and if there be total darkness, we cannot see at all. The eye is very delicate, and is easily injured; but a thin covering hangs over it, called the eyelid, which is pulled over the eye when we fear that it will be hurt; and this eyelid is always closed when we go to sleep. The eye is also protected by some little hairs which grow out from the edge of the eyelid, and are called the eyelashes. These eyelashes keep small particles of dust and flies from going into the eye, and likewise form a shade to keep off the too powerful glare of the sun.

Some boys and girls lose the use of their eyes by severe distempers, and some old persons also are deprived of their sight by injuries, which is a great misfortune. Persons who cannot see are said to be *blind*, and they are not able to go anywhere, without groping with their hands or their feet, lest they fall or stumble. They have to use the sense of touch instead of the sense of sight, and are obliged to trust to other persons telling them what many things are like in

the world. Yet blind people are often very happy and cheerful, because they know that it would be useless to murmur at their lot, and because all good people are kind to them. Schools and books have been provided for the blind, who are taught to read by passing their fingers over raised letters in books printed for their use. Thus the happiness of this class of unfortunates is greatly increased, for by reading they can learn every thing else.

A small part in the centre of the eye is clear, like a looking-glass, and all the objects we see are reflected on it. This reflection of objects is like a little picture in the eye, and the picture is carried by a nerve to the brain, which gives us the idea of seeing. It is very difficult to understand how the mind is made acquainted with the picture of the objects in the eye, so as to give us the idea of seeing; but when we are more advanced in our studies, we shall be better able to comprehend the process of vision, and also the action of light.

The organs of the sense of hearing are the *ears*. The sounds that are made enter the orifice or opening of the ears, and strike against a membrane which is spread like a drum inside, and from that the mind has the idea of hearing. Some sounds are pleasant to hear, and others are unpleasant. Sounds which are pleasingly arranged, are said to be in *harmony* with each other; and those which are displeasing, are called *discordant*. Some persons are so unfortunate as to lose the sense of hearing, and then they are *deaf;* they cannot hear any thing that is said to them, or any sounds that are made. It is by the sense of hearing that we enjoy *music*, which is an harmonious arrangement of sounds made by the voice in singing, or by instruments, such as flutes, violins, and pianos.

The *nose* is the organ of the sense of smelling. Fine nerves are spread over the inside of the nostrils, and these are able to smell any odour which is in the air, or which comes from any flowers or other objects having a scent.

The organ of the sense of tasting is the *tongue*, which is also covered with fine nerves, and those in a moment distinguish or know the taste of any thing put into the mouth. Some things are sweet to the taste, and some

bitter; and some articles have no taste of any kind—they are tasteless or insipid. Smelling and tasting are the least useful of our senses.

The hand is the chief organ of touch or feeling; but the sense of feeling extends all over the body. The ends of the fingers have very fine nerves for feeling. The sense of touch is of great service in assisting or helping the sense of sight. Little children learn the shape of many things by both seeing and handling them. In this way, by the senses acting together, we in time learn to know the shapes or figures of things, and to distinguish one object from another.

By exercising or making use of all our senses, and remembering to the best of our ability what we see and what we hear, we gain *experience*, and are better able to take care of ourselves. Thus, the senses are of very great use to us. They are like roads or avenues, by which knowledge reaches the mind; and without them, we should be in a state of total ignorance.

Quadrupeds, birds, and other animals, have the same senses as mankind, but in some cases their senses are much more powerful. The cat has a much stronger sense of hearing, and some kinds of dogs have a much stronger sense of smelling, than we have. The reason for this is, that the cat has to listen for the approach of its prey, such as mice, in darkened places; and some dogs have to seek out or hunt their prey by the scent which the prey leave behind them. Other dogs, which do not hunt by smell, but by sight, possess a powerful sense of seeing, by which they can perceive the animals they are seeking at very great distances.

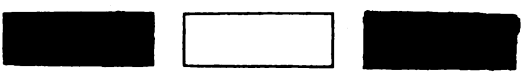
Cats have the power of enlarging the seeing part of their eyes, so as to see much better than we can when there is partial darkness; but when light is altogether withdrawn, and there is total darkness, cats are not able any more than human beings to see any thing. The Creator has given all other animals senses more or less powerful to suit their nature or necessities. Nothing has been made imperfect.

COLOURS AND TINTS.

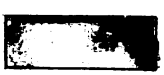
All the works of nature have been contrived so as to give pleasure in looking upon them. The sky, the fields, the flowers, the covering of animals, and, generally, all things possess the most lovely *colours* and *tints*, and these colours we delight to look upon. The colour which the eye can look longest upon with pleasure, is green; and, therefore, there is more of green than of any other colour in nature. Some greens are bright and light, and others are of a darker shade or hue; and these varieties are seen in the herbs of the field, and the leaves of trees and bushes.

There are many different colours or tints in the works of nature, and also in objects made by the art of man; but all the colours that we behold or can imagine, are formed of only three colours, called the *primary colours*—the word primary signifying first or original. The three primary colours, out of which the others are formed, are red, yellow, and blue, as here represented.

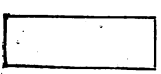
Red. *Yellow.* *Blue.*



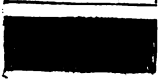
When these colours are mixed in different ways, they form other colours or tints, called *compound colours*—the word compound signifying a putting together or mixing of two or more things, and so making them into one. The following are some of the principal compound colours:—



Green, which is a mixture of yellow and blue. The more blue and less yellow there is in the mixture, the green is the darker.



Orange, which is a mixture of yellow and red.



Purple, which is a mixture of blue and red. By adding more blue to the mixture, we make violet.

Brown, lilac, drab, grey, and other colours or tints, are in the same manner formed by mixing the primary colours. White is perfect lightness, or the absence of all colour, and black is perfect darkness. Properly speaking, white and black are not colours, but they are seen both in nature and art. Snow gives us one of the best examples of whiteness; and pure linen and cotton cloth and paper are likewise very white. White is sometimes called *blank*, as, blank paper. Perfect darkness at night, or in a room where there is no light, gives an example of black. Some clothes are dyed black, and so are men's hats, most frequently.

A beautiful example of the various colours in nature is seen in the bright tints of flowers, and the plumage of birds. The rainbow also shows a fine assemblage or meeting together of colours placed in *harmony*, or in an agreeable connection with each other. The colours of the rainbow, which are caused by the shining of the rays of light of the sun through the drops of rain in a shower, consists of the three primary colours, and four compound colours, in the following arrangement, beginning at the top of the bow—red, orange, yellow, green, blue, purple, and violet. This arrangement of colours is also seen in the shining of the rays of light through a triangular piece of glass, called a *prism*, and they are therefore sometimes called the *prismatic colours*. A six sided or hexagonal prism is sometimes employed for the same purpose.

SPEAKING—LANGUAGE.

Men express the ideas in their minds, or their thoughts, by certain sounds uttered by their mouths. The *tongue* is the chief thing used in making these sounds, which are called *language*, from a word meaning the tongue. To utter such sounds is to speak, and the power of uttering them is called *speech*. Beasts, birds, and other inferior animals, have not the power of speech; although they have some kind of feelings, they cannot make known these feelings in *words*. All that such animals can do in the way of speaking, is to make certain *sounds* or *cries*. The horse neighs; the dog barks, growls, and whines; the cock

crows; the hen cackles and clucks; the cow lows; the sheep and lambs bleat; lions roar; birds sing and chirp; frogs croak; and snakes hiss. By such sounds they express pleasure, or pain, or anger, or defiance, or supplication. In general, the animal only means to let its companions know that it is near at hand. When the blackbird whistles, its mate hears the far-sounding notes, and comes quickly to it.

The sounds and cries which these animals make are sometimes called the language of beasts and birds, but it is a language of a very imperfect kind. Parrots, mocking-birds, and cockatoos can be taught to utter words, but they do not know the meaning of what they say; they only repeat by rote what they are taught.

THE COCKATOO.

There is a bird of plumage rare,
  In gilded cage exposed to view,
Procured with cost, preserved with care—
  We mean the *pretty cockatoo.*

He is a foreign bird of fame,
  And talks as parrots often do;
For if we ask him what's his name,
  He'll say 'tis *pretty cockatoo.*

Yet in these words repeated o'er,
  Does all this scholar's wisdom lie;
For to a thousand questions more
  He only gives the same reply.

If asked who made his gilded cage,
  Or who his master's portrait drew,
Who was in Greece the wisest sage?
  He'll say 'twas *pretty cockatoo.*

Thus many children sent to school,
  Perform the same unmeaning rounds;
Learn all by oft-repeated rule,
  Yet see no meaning in the sounds.

But we should never thus by rote
  Run day by day our lessons through,
And never give the sense a thought,
  Like prating *pretty cockatoo.*

A bird may come to sound its name,
  A bird may almost learn to spell,
But boys and girls may surely aim
  At something more than birds can tell.

The wreath which winds round wisdom's bough
  Is free to all, though cropp'd by few;
And we may pluck a leaf e'en now,
  And shame the *senseless cockatoo.*

The want of the powers of thought and speech keeps the lower animals in a humble station, far below that of human beings. They cannot tell each other where they were born, or how old they are, or what is their name, or any thing else connected with their condition. They, therefore, cannot instruct each other, or lay plans to make themselves happy. And though we were to make any mere animal very clever at playing tricks, still that animal's young ones would be just as ignorant as ever. All living creatures, except mankind, are fixed down for ever to a humble condition, and can be easily subdued and ruled over.

The faculty of language has been given to mankind for the wisest of purposes by his Creator. We are able to speak, because our minds have the power of thinking or reflection, and because our tongue is able to utter the words which the mind thinks upon. The tongue, and the windpipe through which the sounds come, are called the *organs of speech.* Some persons are so unfortunate as to be unable to speak, and they are said to be *dumb.* [Such persons are usually *dumb*, because they are *deaf*, and are hence called *deaf mutes.* Good men have opened schools for the deaf and dumb, so that such persons are now taught to speak by signs, and thus learn to read and write, though they cannot speak.]

By speaking, we can communicate our thoughts to each other. We can tell of all the things that we have heard of from our fathers; and men who are learned, and have studied much, can tell the young and the ignorant of many things that they would perhaps never find out themselves. In this manner, by one telling another, every new generation is a little more intelligent than that which went before it, by which means the human mind is greatly improved.

All persons learn to speak when they are very young, and they are generally taught to speak by their mothers. On this account, the language which any person first learns to speak, is called his *mother-tongue*. All persons should try to speak as well as they can. They should always speak plainly in words which can be well understood, and in all cases speak nothing but the truth. They should never say one thing and mean another, for that is the same as lying, and lying is one of the worst of vices. Every person, also, whether young or old, rich or poor, should avoid coarse or improper language, and always speak kindly to one another, so as not to hurt the feelings of any one by harsh expressions.

Almost every nation has its own form of speech or language; so that the people of one country do not understand what the people of another country say. The language which we speak is called the *English* language, because it was first spoken by the people of England. The language spoken in France is called the *French* language. The language which was spoken by the ancient Jews, whose history is told in the Bible, is called the *Hebrew* language; and it is now not generally spoken by any people. The language which was spoken in a country called Greece, about two thousand years since, is called the *Greek* language; and it is now, also, not generally spoken by any people. The language which was spoken by a people called the Romans, who existed about the same time as the Greeks, is called the *Latin* language; and it is now, also, not generally spoken.

The Greek and Latin languages, in consequence of not being now spoken by any nation, are usually called *dead* languages; they are, also, called the *learned* languages, or

the classics, because many learned men wrote their works in these languages.

FORMS OF OBJECTS.

All the objects which we see possess a certain *form* or *shape*. We know forms or shapes by the senses of seeing and feeling, and by *comparing* them in our minds with other forms and shapes. It is very useful to be able to perceive, recollect, and name, the shapes of things. Those who do not pay attention to this, can never tell the exact form of any thing; they are always making mistakes, and frequently do not understand what people say to them. Let us try to avoid this appearance of ignorance, and make ourselves well acquainted with the different forms of objects, and the names which are ordinarily given to them.

Every one knows what a *straight* line is. It is a line drawn straight from one end to another. If we take a piece of paper, a ruler, and a pencil, and draw the pencil along the edge of the ruler on the paper, we shall draw a straight line, thus _____ Also, if we fold the paper evenly, we shall make a straight line by the fold: a straight line, therefore, can be understood, although it is not marked with ink or a pencil.

A straight line may be in any direction, up or down, or sidewise. When it is level, or even from one side to another, it is called a *horizontal* line; when it is even up and down, it is called a *perpendicular* or *vertical* line.

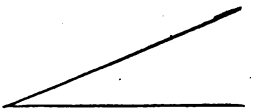
Horizontal line.

Perpendicular line.

The following is an example of a perpendicular line rising from a horizontal line.

Straight lines may also be *oblique* or *diagonal*, thus,

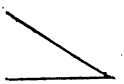
The following is an example of an oblique line rising from a horizontal line,



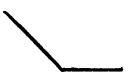
Sometimes a line sloping up in this way is called an *inclined plane;* a sloping road going up a hill is an inclined plane.

When one line rises straight up from another, as in this case,

the corner which is made where the two lines touch, is called a *right angle.* If the line rises with a slope, thus,



the corner or point where the lines join, is called an *acute angle.* But if the line rises or goes off in this way



the angle is called an *obtuse angle.*

Four straight lines of equal length joining together, so as to make four right angles or corners, form a *square* or

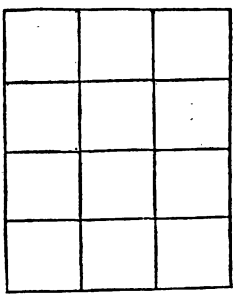
quadrangle. If the lines on opposite sides be longer than the other two at the ends, an *oblong* or *parallelogram* is

Square.

Parallelogram.

formed. It is called a parallelogram, because the lines are parallel to each other, or lie evenly opposite each other.

Here is a figure of a window; it is formed of twelve



squares with four perpendicular lines, and five horizontal lines. All the corners of the squares are right angles. When lines cross in this manner, they are said to *intersect* each other. When a pane of glass is broken in a window, it generally shows cracks in all directions, some horizontal, some perpendicular, and others oblique.

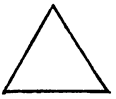
We see straight lines in many objects of art. The edge of a book or of a table, the seams in the floor, the roof of a house, and the sides of doors, are examples of straight lines. When an object has four sides of equal size, and is perfectly square, it is called a *cube.*

A *pyramid* is an object with four equal sides, but the sides become small or narrow as they rise and come to a point at the top, thus,

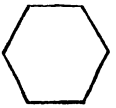
[When it has six sides it is called a six-sided or hexagonal pyramid.]

The top of figures of this kind is called the *apex*. The bottom of all buildings, of whatever form, is called the *base*.

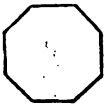
When three straight lines join each other, they form a *triangle*. The side of a pyramid is triangular. An object with six sides of equal length has six corners or angles, and is called a *hexagon*. An object with eight sides of equal length is called an *octagon*.



Triangle.



Hexagon.



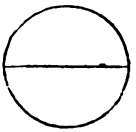
Octagon.

All lines are not straight. There are lines with curves or bendings. Here is a *curved* or bent line.

We see many instances of bent lines both in the works of nature and art. There are, indeed, very few straight lines in nature; trees are curved or round in their stems, the sun and moon are round in figure; rivers turn and wind in their course; and our own bodies are full of curves or bends. Bent lines are more beautiful than straight ones; but it is always shorter to go in a straight line than in one with turnings.

A figure drawn perfectly round is called a *circle*. The entire line forming a circle is the *circumference*; and a line

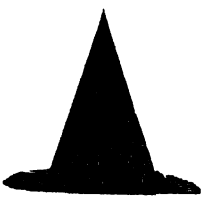
drawn across the middle or centre of a circle, from one side to another, forms the *diameter;* [one half of which is called semi-diameter, or the radius of a circle.] The half of a circle is called a *semicircle.*



A *crescent* is a portion of a circular object, thus. The moon has the appearance of a crescent when it is new, or only a few nights old.

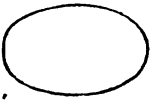
The figure of a tube or a roll of paper, is an example of a circle and straight lines in one object. The roll is round, both on the outside and inside, while the lines along from one end to the other are straight. The lines of the sides are also parallel to each other. An object of this form is also sometimes called a *cylinder.*

A roll may be made with a piece of paper, so as to have oblique, not parallel sides. A figure of this kind is called a *cone,* or its shape is called conical. A sugar loaf is conical, broad at the base, and small at the apex.



Some figures are of an *oval* form, thus. An oval is also called an ellipsis. The oval is not a true round or circle; it is like a circle drawn out on two opposite sides. An egg is oval or elliptical in figure, but it is not a perfect oval,

because one end of the egg is generally smaller than the other.



Every young person knows what is meant by a flat surface. The table is flat, the floor is flat, and many other things are flat. Some objects, however, are not perfectly flat; they have a rounded or bulged out surface. When a surface rises in this manner, it is said to be *convex.* Here is a specimen of a convex surface rising from a flat surface.

Some objects are convex on two sides, or doubly convex, thus,

The glasses in spectacles are generally convex, or thicker at the middle than they are at the sides.

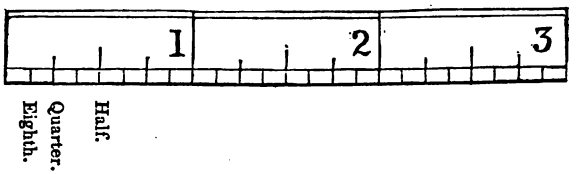
Surfaces may be *concave.* A concave surface is a rounded hollow like the inside of a basin. A flat object may also be hollowed out so as to form a concave surface on one side, or it may be hollowed on both sides to form a double concave.

[The figures presented in the foregoing lesson are necessarily only rudimental. By means of chalk, a pair of large compasses, and the black board, innumerable combinations of straight and curved lines may be formed, so as to serve an important end in intellectual exercise.]

SIZE AND MEASUREMENT OF OBJECTS.

Objects are of different sizes; some are large and some small. A hill is larger than a house, a man is larger than a boy. We know the size of objects, in the same way that we know their shape, by the senses of seeing and feeling, also by comparison. Objects have three qualities in their size—length, breadth, and thickness. These qualities are called their dimensions. The longest way of an object is its length. From the top of a book to the bottom is its length; from one side to another is the breadth; and its thickness is its bulk from the outside of one covering through to the outside of the other.

The length of objects can be measured. We may measure the length of a piece of cloth, and measure the distance from one place to another. There is an object called a *foot-rule*, which is used by carpenters, and a yard-stick used by tradesmen, for measuring the lengths of things. This consists of thirty-six equal portions, called *inches*, and each inch is divided into halves, quarters, and eighths. The following is a representation of three inches of a foot-rule.



Each inch is seen to be divided into eight parts or eighths; and in the first inch, the eighth, quarter, and half of the inch, are marked. Twelve inches make a *foot*, and thirty-six inches, or three feet, make a *yard*.

The distance from one place to another is measured by miles. Seventeen hundred and sixty yards make a *mile*, which is a space that a boy may easily walk without being tired. Some streets in large cities are a mile or more in length. Three miles form a *league*, but it is chiefly distances at sea that are measured in leagues.

The *height* of objects can be measured in the same manner as their length. We can measure the height of doors or windows, or houses, or the height of mountains. The doors of rooms are generally from six to seven feet high; some houses are fifty feet high, but others are sixty or seventy or more feet. Some hills are one mile, and others several miles in height. The length downward of objects is called *depth*, and can be measured the same as height. Some wells are a hundred feet deep, and many coal-mines are five hundred feet deep.

Some objects are *heavier* than others. A large stone is heavier than a small stone; a piece of iron is heavier than a piece of wood of the same size. Many articles are sold by their *weight*, which is the measure of their heaviness. A common measure of weight is a *pound;* there are several pounds of weight in a large loaf of bread. A pound consists of sixteen parts called *ounces;* and an ounce is divided into halves and quarters. Shopkeepers who sell tea, and sugar, and other articles, make use of these weights. [This is called Avoirdupois weight. But in Troy weight and apothecaries' weight there are only twelve ounces to the pound.]

Liquid substances are measured by quantity. The most common measures of quantity are *gallons*, *quarts*, and *pints*. There are two pints in one quart, and four quarts in one gallon.

ART OF WRITING—BOOKS.

Writing is the art of making certain marks to signify spoken language. The marks which we use are the letters of the alphabet; letters are selected according to their sounds, and joined together to form *syllables*, and syllables form *words*. Some small words, as *of*, *to*, and *from*, are only of one syllable, and are called monosyllables, but longer words are of two syllables, and are called dissyllables; the word *re-mem-ber* has three syllables, and is called a trisyllable, while a word of more than three syllables is called a polysyllable. The joining of the proper letters in words is called *spelling*. A number of words together form

a *sentence*. We know how to employ proper words in writing or speaking, by having learned the rules of *grammar*. [The best way to teach young persons language, is by directing them to write words, and short sentences upon their slates or black board, thus composing for themselves. The correction of their errors and the explanations of their teacher, will introduce them to both the definitions and rules of grammar, so far as these are worth learning.]

The rules of grammar should be learned by young persons at school, so that they may know how to write and speak correctly when they grow up. If we be ignorant of the art of spelling words rightly, and of using the proper words in speaking, we shall be thought very meanly of. It will be said of us that our education has been neglected. None but uneducated persons say, *We was, I knows it*, or *It was me did it*. A rightly educated person, who is acquainted with the rules of grammar, says, *We were, I know it*, and *It was I who did it*.

In order to write language correctly, we must also know how to put *points* after the words. This is called *punctuation*. Points are small dots or marks placed at proper situations between words and at the end of sentences, to prevent confusion in the language, and to show where we should make pauses in reading. The most common points are small marks called *commas*, which are put after the smaller divisions of sentences. This is a comma , which is a dot with a tail to it.

The points put between larger divisions of a sentence are called *semicolons*. A semicolon is a comma with a dot above it, thus ; a colon shows a little longer pause, thus : and is made by placing one dot above another. The points put at the end of sentences are called *periods*. They signify that a full stop is made. A period is a single dot thus . There are a few other points, but they are not much used. One is called a *mark of interrogation*, and it is always put after the words asking a question. This is its shape ? Another point is called a *mark of admiration*, and is always put after words expressing surprise. It is a dot with a long mark above it, thus ! The *hyphen* is a small mark, thus - which is used for joining two words together,

or at the ends of lines when words are halved. [The apostrophe ' is used to denote the possessive case, as *Mary's* book, and it is also employed when letters are left out, as in *heav'n*, and *tho'* for though.]

In the course of writing, when any thing has to be said not immediately connected with the subject, but which it is of use to notice (as when a person in the course of conversation turns aside to say a few words to another person), this may be done in two ways. *First*, The thing that is to be said may be inserted in the writing within marks called *parenthesis*, thus ( ). Sometimes a *dash*, thus — is used instead of a parenthesis, and also instead of a comma. *Second*, The thing that is to be said may be written at the bottom of the page in a note, with a mark referring to the note. There are many kinds of marks of reference to notes; the most common is a *star*, thus * and a *dagger*, thus †. When we come to any mark of this kind in reading, we stop, and read the note at the bottom of the page to which it refers. Notes are usually explanations of circumstances connected with the subject, and are in smaller letters. [There are also quotation points, thus " at the begining, and thus " at the close of the sentence or word taken from another author or speaker; two inverted commas being used in the first case, and two apostrophes in the other. A single mark is used when a quotation is in a quotation, thus ' and thus '.]

Writing is of great service to mankind. It enables a person to mark down his thoughts on any subject, so that they may be preserved in books, or sent to another person to be read at a great distance. By this means, thoughts are handed down safely from one generation to another, and communicated from one place to another all over the world. A person who can write has it in his power to tell another friend what he is doing, or what he wishes to be done, although that friend be situated thousands of miles distant.

[Children are often taught the alphabet by writing in the sand. Slates are much used in the early lessons in writing, and it has many advantages.] But writing is usually executed with ink and a pen upon paper. The letters of the

alphabet which are employed in writing, differ in shape from the letters which are used in books. The following are the letters used in writing or penmanship:

CAPITALS.

A B C D E F G H I J
K L M N O P Q R S
T U V W X Y Z.

SMALL LETTERS.

a b c d e f g h i j k l m n o p q
r s t u v w x y z

By using these sloping letters, and making them join each other in words, writing is quickly performed, the right hand holding the pen.* Letters from one person to another are written in this manner in small writing. A specimen is given in next page, of a letter which was written from a boy at a school in the country to his mother in town. He is here seen writing his letter at a desk.

* This writing alphabet is presented simply with the view of exciting in the pupil's mind an idea of the nature of penmanship, and may be passed over in teaching.

Bordentown, N. J., September 5, 1845.

My Dear Mother,

It gives me much pleasure to inform you that I arrived safely by the Rail Road at Bordentown, and am now quite well. My teacher was glad to see me on my return to school, and he has been so well satisfied with my progress in reading and writing, that he says he will put me into a higher class, to learn some of the useful Sciences. I know that this will delight you, but it will delight my uncle William much more, for he told me that every boy should get a knowledge of science at school, and he hoped that I would pay attention to what my teacher said on the subject. I beg to offer my kind love to my dear sister Mary, and remain, dear Mother,

Your affectionate Son,

Robert Harley.

When a person writes his name at the bottom of a letter or paper, it is called *subscribing* his name. After a letter is folded and sealed, the name and place of residence of the person to whom it is written are put on the back. This is called the *address*. The letter is then put into the post-office, to be sent according to its address or direction.

Writing is sometimes done with *pencils* made of black lead, but the writing that is done with them is easily rubbed out with India-rubber, and therefore the writing is very imperfect. Writing may also be done with a piece of slate-pencil on a slate. Writing is most usually done on *paper*. In ancient times, people wrote upon the smoothed skins of sheep, also on the thin bark of trees, and on the large leaves of plants.

The art of making paper became known about six hundred years ago, and since that time paper has always been used for writing upon; it is a fine smooth white substance, much superior to skins, the bark of trees, or leaves of plants. Paper is made from old rags of linen and cotton. These are cut and bruised down into a stuff like powder, mixed with a glutinous liquid, and spread out into large thin sheets. The sheets, on being pressed smooth and dried, form paper. Paper is now made in great quantities in England, Scotland, and other countries.

[Black ink is generally used in writing, and is made by dissolving in water a mixture of copperas, which contains iron, and powdered nut galls. The black colour depends on the iron which is used in making ink. Red ink, blue ink, &c. are made by different compositions to be learned hereafter. We can generally buy ink of any kind cheaper than we can make it.]

A sheet of paper is folded so as to form a number of leaves; and one side of a leaf is a page. A collection of leaves, bound together, form a *volume* or a *book;* and a collection of books of various kinds form a *library*.

Some volumes are large and others small, according to the number of leaves into which the sheets have been folded. When the sheet has been folded into two leaves it is called a folio, when into four leaves, the book is called a *quarto*, from the Latin word signifying four. When the sheet has

been folded into eight leaves, it is called an *octavo*, from the Latin word for eight. And when the sheet has been folded into twelve leaves, it is called a *duodecimo*, from the Latin word for twelve. Sheets are often folded into eighteen leaves, or into twenty-four leaves, and in these cases the books are of a small size, and called 18mo. or 24mo. &c. A *quire* of paper contains 24 sheets, and 20 quires of paper make a *ream*, writing paper being usually in bundles containing a ream or half ream.

ART OF PRINTING—LITERATURE.

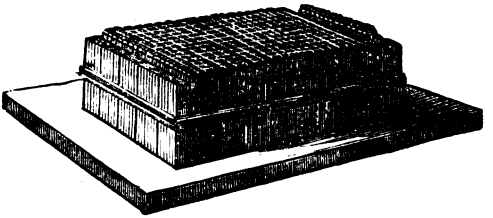
In ancient times, learned men wrote what they had to say on any subject in a book made of the leaves of plants sewed together, or upon the skins of animals called parchment, and other persons copied these books by writing, so as to make a number of copies of one thing All books were written with so much labour, and loss of time, that they were very scarce, and so very dear that none but the rich could purchase them. A single copy of the Bible in these times was sold for as much as four hundred pounds. This slow and dear way of preparing books continued till the art of *printing* was invented, about the year 1437; that is, upwards of four hundred years since. Printing was invented by a person called John Guttenberg, a German, who lived in the town of Mayence in Germany, and from that place a knowledge of the art of printing soon spread into England and other countries.

Printing is done by means of *types* and a printing-press. Types are small objects, made chiefly of lead and another metal called antimony, and are about an inch in length. For every letter in the alphabet, large and small, there is a particular type, with that letter shaped on the end of it, so that, with this shaped end, the letter can be stamped on a piece of paper.

A representation is here given of the letter s. Types are arranged in divisions or boxes in a case, each box having a number of its own letter in it; and when printing is to be performed, a letter is taken from one box and a letter from another, till words are formed

by the types, and these words are made to stand close together in lines. In this way, whole pages are put up in types.

Here is a view of a small page of types tied together with a piece of string, and standing on a board.



After the types are put up in pages, they are laid on a flat surface in a printing-press, and thinly covered with ink, by means of a soft roller. A sheet of paper is now laid upon them, and the press being pulled hard on the back of the sheet, an impression is made. Another is made in the same manner, and so on till many hundreds are printed. After all the sheets have been printed on one side, they are printed on the other, and this finishes the work.

Here is a picture showing a man working at a printing-press, of the old fashion. After all the printing of a sheet is done, the types are put back into their boxes, and are again set up in new pages, which are printed in the same

manner. In this quick and simple manner, books of all kinds are printed, sheet after sheet, at a very cheap price. Instead of a Bible selling for four hundred pounds, as it did before the invention of printing, it is now sold for 25 cents, by which means very poor persons can now afford to buy one to read. [The improvements in the printing-press, by which it is worked with a steam engine, have been the means of thus cheapening the price of Bibles and all other books. What is called stereotyping contributes to the same result, and consists of casting the types into a plate for permanent use.]

The persons who write the matter that is to be printed in books, receive the name of *authors*. The writings of an author, after having been printed, are called the author's works, or his productions. The persons who carry on the business of printing, are called *printers*. After the sheets of a book are printed and folded, they are sewed together, and bound in boards to keep them firm; and the persons who bind books are termed *bookbinders*. As soon as the books are bound they are taken to shops, and sold by *booksellers*.

There are two kinds of writing for books—*prose* and *poetry*. Most books are written in prose. Prose consists of words forming lines completely across the page, and the lines follow each other, as in the present book, from the top to the bottom of the pages. A number of lines together forming a division of the subject, make a *paragraph*.

Poetry is writing in *verse*, and the language is of a refined description, often referring to things of an imaginary character. In verse, each line has a certain number of syllables, generally eight or ten, and each line begins with a capital letter. A piece of composition in poetry is termed a *poem*, and the writer of such pieces is called a *poet*. All songs, hymns, and psalms, are in poetry. In many cases, the last words in the lines of poetry are of the same sounds, or *rhyme* with each other. I can point out the words which rhyme with each other in the poems in this book.

All printing in books, whether in prose or poetry, is now done in words composed of letters of the *Roman* alphabet. It is called Roman because it was invented by the Romans,

a people in times long past. Sometimes a word is printed in letters of the *Italic* alphabet; when this is done, it is meant that the word is of importance, or requires particular attention from the reader. It is not considered a good style of writing to make many words in italic, or to have many notes. The plainest and most easily understood writing is the best.

Occasionally, on the title-pages of books, and in ornamental writing, letters are used from the *German* alphabet, which is so called from being the alphabet with which books are printed by the Germans. The following is the German alphabet, or German text :—

CAPITALS.

A B C D E F G H I J K L M N O P Q
R S T U V W X Y Z.

SMALL LETTERS.

a b c d e f g h i j k l m n o p q r s t u v w x y z.

The Lord's Prayer.

Our Father which art in Heaven. Hallowed be thy Name. Thy kingdom come. Thy will be done in Earth, as it is in Heaven. Give us this day our daily bread; And forgive us our trespasses, as we forgive them that trespass against us. And lead us not into temptation; But deliver us from evil; For thine is the Kingdom, the power, and the glory, For ever and ever. Amen.

In writing and printing the English language, certain contractions of words, and also some small words from the Latin, are used. A common contraction is the figure &, which signifies *et* or *and*, et being the Latin word for *and*. When a small letter c is put after the figure, thus, &c., it signifies *et cetera*, which means *and the rest*, cetera being the Latin word for *the rest*. It is often put at the end of lists of things, to signify that there are some more things of the same description, which it is not necessary to enumerate.

Ditto, or its abbreviation *do.*, is used to signify *the same*, that being its meaning in the Italian language. *Ibid.* or *ib.* are contractions of the Latin word *Ibidem*, which also signifies *the same*. *Viz.* is a contraction of *Videlicet*, which, as commonly used, signifies *namely*, and it is read as the word *namely*, when it occurs in a book. *Vide* is a word in Latin signifying *See*, and in that sense it is occasionally used in referring to things which may be seen in a particular page or book. At the end of books the word FINIS is sometimes put: it signifies *The End*, that being its meaning in Latin.

All books whatsoever form what is called Literature, being so styled from the Latin word *litera*, a letter. The books in the English language are termed *English Literature;* books in the French language, *French Literature;* and so on with the books in other languages. Works in the Latin and Greek tongues are styled *Classical Literature*, because they have been long held in estimation in the studies of classes in schools. Any person who is fond of reading, and of deriving amusement and instruction from books, is said to have a taste for literature, or is fond of literary recreations.

It is a mark of intelligence to feel pleasure in the pursuits of literature, for books contain large stores of information on all subjects; and from them we may draw the best advices or counsels for our guidance. It is only by the study of good books, along with our own experience in life, that our minds can be either instructed or improved.

COUNTING—NUMERALS.

Counting is useful for telling the number of things, or how much money any thing costs. The common way of counting is by words, as, when a boy counts his fingers, and says—*one, two, three, four, five, six, seven, eight, nine, ten.* But when people write the number of any thing in a book or on a slate, they adopt a shorter method than writing the words; they generally mark down *figures* instead of words, because a single figure can express a whole word, or even several words.

There are only ten figures altogether. Here they are with their names beneath them:

1	2	3	4	5	6	7	8	9	0
one,	two,	three,	four,	five,	six,	seven,	eight,	nine,	nothing.

All numbers, no matter how great, are written down by these figures alone, in the same manner that all words are written, by joining the letters of the alphabet.

The last figure 0, is usually called *nothing* or *nought*, and it is also called a *cipher*, because, when it stands by itself, it means nothing, or no number at all. But when we put it after 1, thus, 10, we make ten; when put after 2, we make twenty; the cipher is thus put after other figures to make them mean large numbers. When two ciphers are put after 1, as 100, it means a hundred; and when three ciphers after 1, as 1000, it means a thousand.

The numbers 1, 3, 5, 7, 9, 11, 13, and so on, are called *odd* numbers; and 2, 4, 6, 8, 10, 12, and so on, are called *even* numbers.

The following is the manner of counting in figures and words:

1 one	6 six	11 eleven
2 two	7 seven	12 twelve
3 three	8 eight	13 thirteen
4 four	9 nine	14 fourteen
5 five	10 ten	15 fifteen

16 sixteen	45 forty-five	74 seventy-four
17 seventeen	46 forty-six	75 seventy-five
18 eighteen	47 forty-seven	76 seventy-six
19 nineteen	48 forty-eight	77 seventy-seven
20 twenty	49 forty-nine	78 seventy-eight
21 twenty-one	50 fifty	79 seventy-nine
22 twenty-two	51 fifty-one	80 eighty
23 twenty-three	52 fifty-two	81 eighty-one
24 twenty-four	53 fifty-three	82 eighty-two
25 twenty-five	54 fifty-four	83 eighty-three
26 twenty-six	55 fifty-five	84 eighty-four
27 twenty-seven	56 fifty-six	85 eighty-five
28 twenty-eight	57 fifty-seven	86 eighty-six
29 twenty-nine	58 fifty-eight	87 eighty-seven
30 thirty	59 fifty-nine	88 eighty-eight
31 thirty-one	60 sixty	89 eighty-nine
32 thirty-two	61 sixty-one	90 ninety
33 thirty-three	62 sixty-two	91 ninety-one
34 thirty-four	63 sixty-three	92 ninety-two
35 thirty-five	64 sixty-four	93 ninety-three
36 thirty-six	65 sixty-five	94 ninety-four
37 thirty-seven	66 sixty-six	95 ninety-five
38 thirty-eight	67 sixty-seven	96 ninety-six
39 thirty-nine	68 sixty-eight	97 ninety-seven
40 forty	69 sixty-nine	98 ninety-eight
41 forty-one	70 seventy	99 ninety-nine
42 forty-two	71 seventy-one	100 one hundred
43 forty-three	72 seventy-two	101 one hundred and one
44 forty-four	73 seventy-three	

1000 one thousand, 10,000 ten thousand, 100,000 hundred thousand, 500,000 five hundred thousand, 1,000,000 one million. The year eighteen hundred and forty-six, is thus written, 1846.

Figures are also used to signify *first, second, third, fourth,* and so on, by putting the letters *st, d,* or *th,* after them in the following manner:

1st	2d	3d	4th	5th	6th	7th	8th	9th	10th
first,	second,	third,	fourth,	fifth,	sixth,	seventh,	eighth,	ninth,	tenth,

and so on with all the other numbers.

A *brace*, a *couple*, or a *pair*,
Are other words expressing two;
But for a *dozen* we declare,
That twelve, and only twelve, will do;
Just twenty for a *score* we take;
A *gross*, twelve dozen always make.

Figures are called common numerals, because they are commonly used for numbering. There are other numerals, which were much used in old times, but which are now chiefly used at the heads of chapters, and on the faces of clocks and watches. These are called Roman numerals, because they are Roman capital letters.

The following is the manner of counting in Roman numerals:

I. one	XX. twenty
II. two	XXI. twenty-one
II. three	XXX. thirty
IV. four	XL. forty
V. five	L. fifty
VI. six	LX. sixty
VII. seven	LXX. seventy
VIII. eight	LXXX. eighty
IX. nine	XC. ninety
X. ten	C. one hundred
XI. eleven	CC. two hundred
XII. twelve	CCC. three hundred
XIII. thirteen	CD. four hundred
XIV. fourteen	D. five hundred
XV. fifteen	DC. six hundred
XVI. sixteen	DCC. seven hundred
XVII. seventeen	DCCC. eight hundred
XVIII. eighteen	CM. nine hundred
XIX. nineteen	M. a thousand

The number of the year is sometimes written in Roman numerals, as MDCCCXLVI. for 1846.

The number which distinguishes a king of a certain name, is generally written in Roman numerals, as Henry VIII. for Henry the Eighth. This means that there were seven kings called Henry before this Henry the Eighth.

The Latin word for *Number* is *Numero*, and it is common to use the contraction *No.* when marking the Number of any thing. For example, No. 37 signifies Numero 37, or Number 37.

When we look up into the clear sky at night, we see many *thousands* of beautiful stars, which sparkle and shine, and give some light by which we may see to walk. Here is a poem on the stars.

THE STARS.—BY MRS. HEMANS.

No cloud obscures the summer sky,
The moon in brightness walks on high,
And, set in azure, every star
Shines, a pure gem of heaven, afar!

Child of the earth! oh! lift thy glance
To yon bright firmament's expanse;
The glories of its realm explore,
And gaze, and wonder, and adore!

Doth it not speak to every sense
The marvels of Omnipotence?
Seest thou not there the Almighty's name
Inscribed in characters of flame?

Count o'er those lamps of quenchless light,
That sparkle through the shades of night;
Behold them!—can a mortal boast
To number that celestial host?

Mark well each little star, whose rays
In distant splendour meet thy gaze;
Each is a world by God sustained,
Who from eternity hath reigned.

What then art thou, oh! child of clay!
Amid creation's grandeur, say?
E'en as an insect on the breeze,
E'en as a dew-drop, lost in seas!

Yet fear you not? the sovereign hand
Which spread the ocean and the land,
And hung the rolling spheres in air,
Hath e'en for thee a Father's care!

TIME.

Every young person knows what the *morning* is; it is the time when we rise from bed and put on our clothes, and when the sun begins to shine. Every one also knows when it is *night;* it is the time when we go to bed, and when the light of the sun leaves us, and it is dark. From one morning till next morning is a *day*.

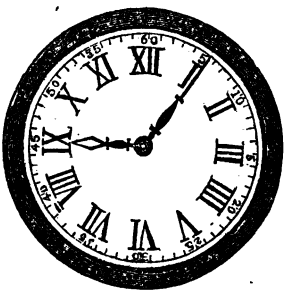
The whole time of a day has, first, the *morning;* then the *forenoon;* then *noon;* after which are the *afternoon, evening*, and *night*. People rise in the morning and take breakfast; from the forenoon till the afternoon they work and walk about; in the afternoon they take dinner; then they work again or amuse themselves till the evening; at night, they take supper, and go to bed, where they sleep till morning. At certain seasons, darkness comes on early in the evenings; and it is then too soon to go to bed, *candles* and *lamps* are lighted, to give us light to see to work, or to read, or to do any thing else that we may choose.

Days are divided into *hours*. In every day there are twenty-four hours. Every hour is divided into sixty *minutes*, and every minute is divided into sixty *moments* or *seconds*. The hours of the day are counted from one in the morning till twelve at noon, which is the middle of the day, when the sun is highest. Then after twelve at noon is past, we begin to count from one to twelve over again. And when this twelve is past at midnight, we go on counting from one in the morning, as before. Mid-day, or twelve at noon, is called *meridiem*, and all the hours after it to twelve at night are called *post meridiem*, or are marked *p. m.*, which means *after mid-day*. All the hours from one in the morning till noon, are called *ante meridiem*, or are marked *a. m.*, which means *before mid-day*.

It is of great use to measure the hours of the day, so that people may always know exactly what hour and minute it is, and do things at proper times. In order that hours may be properly measured, *clocks* and *watches* have been

invented. Clocks and watches are very curious machines, which measure time exactly; and they have dials or faces, with hands on them which point to the hours and minutes. Every boy and girl should learn to know the hour of the day by looking at a clock or watch, and then they will know when to go to school without asking any one to tell them the hour.

Here is a picture of the dial of a watch, with the hours marked round it, from I to XII; also, the minutes of an



hour marked outside from 1 to 60. You likewise see two hands, one short and the other long. The short hand is for pointing out the hours, and is called the *hour-hand;* the long hand is for pointing out the minutes, and is called the *minute-hand.* The minute-hand goes round once every hour, but the hour-hand goes much more slowly, or only from the mark of one hour to another in the space of an hour. When the hour-hand points to XII, it means twelve o'clock; when it points to I, one o'clock; and so on with the other hours. After seeing where the hour-hand points to, look where the minute-hand points, and there the number of minutes after the hour is marked. In the picture here given, the hour-hand points to IX, and the minute-hand to 5, which signifies that it is five minutes after nine. When the minute-hand goes to 10, it will be ten minutes after nine; at 15, it will be fifteen minutes or a quarter of an hour after nine, and so on according to the

marks; at 30, it is half an hour after. When the minute-hand comes round to where 45 is marked, it is called a quarter to ten; at 50, it is ten minutes to ten; and 55, it is five minutes to ten. And when the minute-hand is at 60, the hour-hand has got to X, which shows that it is ten o'clock exactly. All the other hours of the day are known in the same manner, by looking at watches and clocks.*

After young people have learned how to know the hours of the day, then they learn about weeks, months, and years. A *week* is seven days—Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, and Saturday. Sunday is the first day of the week, and it is called the *Sabbath day*, because it is the day of rest. We must not do any work or play on the Sabbath day, but we may work all the other days of the week. Four weeks make a lunar month.

Fifty-two weeks, or 365 days, make a *year*. There are twelve calendar months in a year—January, February, March, April, May, June, July, August, September, October, November, and December. The first day of January is the first day of the year, and it is called *New Year's Day*. The months have not the same number of days. Some have 30, and others have 31; February has only 28 days, but in every fourth year, which is *leap year*, it has 29. The best way to remember the number of days in the months is to learn the following rhyme:

Thirty days have September,
April, June, and November;
All the rest have thirty-one,
But February, twenty-eight alone;
Excepting leap year once in four,
Which gives to February one day more.

[Here the teacher should explain how one day more is reckoned in leap year. Six hours or a quarter of a day over the 365 days in the other years, amounts to one day in four years, and hence 366 days in leap year.]

There are four *Seasons* in a year, Spring, Summer, Au-

* A watch can here be exhibited, and its movements explained, as far as suitable to the capacity of the pupil.

tumn, and Winter, each of three months in length. The months of Spring are March, April, and May; the months of Summer are June, July, and August; the months of Autumn are September, October, and November; and the months of Winter are December, January and February.

After one year is past, another begins, with the same number of months and days over again; and thus years have followed years from the beginning of the world. Mankind reckon the number of years from great events. In our country, and also in other countries, years are reckoned from the birth of Christ, which is called the *Christian era.* Every hundred years from the beginning of this era is called a *century.* Eighteen centuries have already been completed, and we now live in the *nineteenth century.* When we write the year 1838, or 1839, or 1846, it is meant that so many years have elapsed since the birth of Christ.

The precise time at which any event occurs, is its *date.* When people write dates, they mark the name of the place they are writing in, also the name of the month and day of the month, and the number of the year. Thus, *Philadelphia, August* 1, 1846, means that the writing was done at Philadelphia on the first day of August, in the year 1846. Sometimes the date of the year has the letters A. D. before it. These letters are a contraction of the words ANNO DOMINI, which signify THE YEAR OF OUR LORD.

BUYING AND SELLING—MONEY.

Those persons who have many things, *sell* them to others who want to *buy* them. People buy things with *money.* If there were no money, people would have to *exchange* one kind of articles for another, which would be very inconvenient.

Money is small pieces of metal, made into *coins.* There are three kinds of metal used for money; these are gold, silver, and copper. These metals have been chosen to make money with, because they are scarce and difficult to be got. Gold and silver are called the *precious metals,* because they are precious or valuable for their scarcity.

The only person who is at liberty to coin money, is the

king or the government. But the king or government do not make the coins with their own hands; they have servants who make them for them in a place called the Mint. They do not become rich by making coins, because they have to buy the metals to make them with. These metals are very dear, and are brought from foreign countries.

Coins are made by stamping on them with great force, certain words and figures. These words and figures are for telling in what year the coins are issued. One of the most common figures in England, is the likeness of the head of the king or queen. But in America, the coins are stamped with the head of liberty, or a spread eagle, which is the coat of arms of the United States, and sometimes with both, on reverse sides.

One dime.

One cent.

Every country has coins of a different kind. The coins in England are *pennies*, *half-pence* and *farthings*, which are made of copper; *groats*, *sixpences*, *shillings*, *half-crowns*, and *crowns*, made of silver; and *guineas*, *half-sovereigns*, and *sovereigns*, made of gold. [In America, the coins are *cents*, made of copper; *half-dimes* and *dimes*, *quarter dollars*, *half-dollars* and *dollars* made of silver; and *quarter-eagles*, *half-eagles*, and *eagles*, made of gold. Spanish coins of silver are in common circulation, as also *doubloons* of gold, and other foreign coins.]

2 farthings are equal to 1 halfpenny.
2 halfpence are equal to 1 penny.
4 pence are equal to 1 groat.
12 pence are equal to 1 shilling.
2 shillings and 6 pence are equal to 1 half-crown.
2 half-crowns are equal to 1 crown.
20 shillings are equal to 1 sovereign or 1 pound.

In writing down sums of money, the letter *d* stands for pence, *s* or a long stroke | for shillings, and £ for pounds. Thus, £1, 17s. 6d. means *one pound, seventeen shillings, and sixpence.* [In our currency, the mark $ stands for dollars, and *cts* for cents, as $9 25 cts. But as a cent is the hundredth part of a dollar, cents are usually set down thus $9.25, the decimal point being placed before the 25 cents or hundredth parts of a dollar.]

A penny piece of copper is much larger than a shilling, but is only a twelfth of the value. The reason for this is, that copper is much more plentiful than silver. It can be bought in lumps at a much cheaper price. Gold is the least plentiful of all, and is so difficult to be got, that one sovereign is as valuable as twenty shillings, or two hundred and forty pence. Some boys and girls wish that pennies were so plentiful that they could gather them like stones and fill their pockets with them; but if pennies were so plentiful they would not be worth any thing. Every body could get as many as they liked for nothing, and therefore no one would sell things for them. This shows that it is only by the scarcity of money that it is of any value. [All these calculations are made with English money. In America we do not use the sterling currency, but ours is called Federal money, or decimal currency. Thus, 10 cents make a dime, 10 dimes make a dollar, and 10 dollars make an eagle. Moreover, in different states our currency changes. In Pennsylvania and Maryland, a dollar is 7 shillings and 6 pence;—in New York, 8 shillings; while in the Eastern and Southern states, six shillings make a dollar. But the Federal or decimal currency is the same every where, and is much more convenient.]

Notes made of paper are sometimes taken in place of coins. This is done only when coins are difficult to be got, or to save the trouble of taking coins, which are heavy in carrying from place to place. These notes have certain words written upon them that signify what is their value, and that the value in coins will be given for them when they are brought to the persons who issued them. The persons who issue these notes, and take care of money for people, are called *bankers* in England. But in the United

States there are few bankers, most of our paper currency being issued by chartered companies, regulated by law, and called Banks, or by the government, and called Treasury notes.

PROPERTY—LABOUR.

All the things that we see around us, belong to somebody; and these things have been got by *labour* or *working*. It has been by labour that every article has been procured. If nobody had ever done any labour, there would have been no houses, no cultivated fields, no bread to eat, no clothes to wear, no books to read, and the whole world would have been in a poor and wild state, not fit for human beings to live happily in.

Men possess all things, in consequence of some person having wrought for these things. Some men are rich, and have many things, although they never wrought much for them; but the ancestors, or fathers and grandfathers of these men, wrought hard for these things, and have left them to their children. But all young persons must not think that they will get things given to them in this way; all except a very few must work diligently when they grow up, to get things for themselves.

After any one has wrought to make a thing, or after he has a thing given to him, that thing is his own, and no person must take it from him. If a boy get a piece of clay and make the clay into a small ball or marble to play with, then he has laboured or wrought for it, and no other boy has any right to take it from him. The marble is the *property* of the boy who made it. Some boys are fond of keeping rabbits. If a boy have a pair of these animals, they are his property; and if he gather food for them, and take care of them till they have young ones, then the young rabbits are his property also. He would not like to find that some bad boy wished to take his rabbits from him He would say to the bad boy, "I claim these rabbits as my property; they are mine. You never wrought for them; they are not yours." And if the bad boy still would take the rabbits, then the owner would go to a magistrate, and

tell him of the bad boy's conduct, and the bad boy would be punished.

All things are the property of some persons, and these persons claim their property in the same way that the boy claims the marble that he has made, or the rabbits that he has reared. It is very just and proper that every person should be allowed to keep his own property; because, when a poor man knows that he can get property by working for it, and that no one dares to take it from him, then he will work to have things for his own use. If he knew that things would be taken from him, then he would not work at all. He would spend all his days in idleness, and live very poorly.

Some persons possess lands and houses as their property, and are called *landlords* or *proprietors*. As these persons cannot always make use of their lands and houses themselves, they hire or let them to *tenants*, who pay a *rent* for occupying them for a certain length of time. Rents are usually paid to landlords at the end of every half year or every quarter. Some persons pay a rent weekly for their boarding and *lodging* in a house.

When one person wishes to have a thing which belongs to another, he must ask permission to take it, or he must offer to buy it; he must never on any account take the thing secretly, or by violence, or by fraud, for that would be *stealing*, and he would be a *thief*. God has said, "Thou shalt not steal;" and every one should keep his hands from picking and stealing. Some boys think, that, because they *find* things that are lost, they may keep these things to themselves. But the thing that is found is the property of the loser, and should be immediately restored to him without reward; it is stealing to keep it. [We should never take a cent, or even a pin that does not belong to us, for it is as much stealing thus to take a trifle, as it would be to take a large sum, and all thieving begins by stealing little things. The boy who will allow himself to steal a marble or a cent, would steal a dollar or a gold watch if he had a chance.]

God our Heavenly Father has given some things to mankind which are the *common property* of all. The pure

air which we breathe, the light which shines from the sun, and lets us see all things about us, and the water of rivers, and of the sea, are the chief things which have been given us freely to enjoy. If we would have other things, we must make them by our industry from the materials of the earth, which have been provided for us.

PROFESSIONS AND TRADES.

People live by working for money to get food, clothes, houses, and all the other things which they need or would like to have. If they did not work, all the food that has already been produced would soon be eaten up, all the clothes would be worn out, and every thing else would decay, so that the inhabitants of towns, and also those of the country, would be starved, and die very miserably.

The necessity for each person working at some kind of honest labour, is an obligation laid on us by the Creator, and it is a sin to live in idleness, without a desire to work. We are also far more happy when we are working than when we are idle; and this in itself ought to cause us to follow a course of active industry.

As children are not able to work, they are supported for a number of years by their parents; but, when they grow up, they are expected to go and work for themselves. Some young persons are so ignorant, or have such bad dispositions, that they think it would be pleasant for them to live always by their parents or others working for them, and so remain idle all their days. They do not seem to care how much they take from their fathers or their mothers, who are sometimes so greatly distressed with the conduct of their children, that they die of grief. This is very cruel and sinful conduct of these young persons, which no boy or girl should imitate. It is the duty of all who have health and strength, to labour for their own support.

In this large world there is room for all persons living and working at some kind of useful employment. Some are strong in body, and are fitted for working at toilsome professions; others are less strong in body, but have active minds, and they are suited for professions in which little

bodily labour is required. Thus, every young person chooses the profession for which he is fitted, or which he can conveniently follow. Young persons cannot in all cases follow the business they would like; both boys and girls must often do just as their friends advise them, and then trust to their own industry.

As some choose to be one profession and some another, every profession, no matter what it be, has some persons following it as a means of living, and all assisting each other. The tailor makes clothes, the shoemaker makes shoes, the mason builds houses, the carpenter makes furniture, the printer prints books, the butcher kills animals for food, the farmer raises grain from the fields, the miller grinds the grain into flour, and the baker bakes the flour into bread. Although all these persons follow different trades, they still assist each other. The tailor makes clothes for all the others, and gets some of their things in return. The shoemaker makes shoes for all the others, and in the same manner gets some of their things in return; and, in the same manner, all the rest exchange their articles with each other. The exchange is not made in the articles themselves, for that would not be convenient; the exchange is made by means of money, which is to the same purpose. [There is not as much difference in trades and professions as most young people think. Any trade is respectable if attention, diligence, punctuality, and an ambition to excel, be shown by him who follows it, and any occupation may thus be made productive. To gain a good reputation in any calling is easy, by industry and integrity; while without these traits of character, any profession will become disreputable, and unproductive.]

Tailors, shoemakers, carpenters, and others who make articles for use, are *mechanics* or *artizans*, and they form a very large body of the people. The persons who employ a great number of artizans, and give them *wages* for their labour, are *manufacturers*, and these sell the articles they make to *shopkeepers*, who sell them to the public or whoever will buy them. When shopkeepers sell an article they get a little more for it than they paid for it, and that is called their *profit*. If the bookseller pays fivepence for

a book, and sells it for sixpence, then he has a penny of profit. If manufacturers and shopkeepers did not get profit on their articles, they could not sell them, for it is only the profit that they live upon.

The articles or goods made by manufacturers are often bought by *merchants*, who send them for sale to foreign countries, where they are scarce, and where the people wish to buy them. Goods are thus sent to places thousands of miles distant across the sea in ships; and the ships bring back articles from these places which cannot be got at home. The tea, sugar, and many other articles which we daily use, are in this manner brought from far distant countries. The intercourse which takes place between the merchants of different countries and places, in the buying and selling of goods, is called *commerce* or *trade*.

A city where much merchandise is produced, is termed a *manufacturing* city. A city where much commerce is carried on, is called a *commercial* city. Manchester, Birmingham, and Sheffield, in England, are great manufacturing cities. London and Liverpool are great commercial cities. Glasgow is both a manufacturing and commercial city. [These are all in Great Britain, but in America we have many manufacturing cities and towns, as Pittsburg, Paterson, Lowell, Lynn, &c., and New York, Boston, Philadelphia, Baltimore, New Orleans, &c., which are great commercial cities. Even in these however manufactures are extensively carried on.] Commercial cities are usually situated on navigable rivers, or on the shore of the sea, in order that ships may sail up to them, and transport the goods that the merchants have for sale. The buildings where goods are stored up, are called *warehouses*.

Many persons in society are usefully employed in instructing, amusing, or taking care of others. School-masters and mistresses instruct youth in schools, and tutors and governesses give instructions in private families. Clergymen instruct the people in their religious duties, and endeavour to persuade them to lead a good life. Authors of books, editors of newspapers, musicians, painters of pictures, and others, delight and amuse their fellow-

creatures, and keep them from wearying in their hours of leisure. Physicians cure people of their illnesses, and surgeons heal wounds.

All persons are expected to be in some way useful to their fellow-creatures. Some people, both young and old, are lazy or idle, and will not work at regular employment, and others spend improperly the most of the money which they earn. All these fall into a state of wretchedness and poverty. They become *poor*, and are a burden on society. Other persons are unfortunate in their business, and lose all that they have made, so that they become poor also. Persons who suffer hardships of this kind should be pitied, and treated with kindness by those who are able to help them. Many persons, besides, become poor by old age and infirmity, and it is proper that they should be taken care of and supported. A *beggar* is a poor person who does not feel ashamed to seek alms. Any one who is able to labour for a subsistence, should feel ashamed either to beg or to be classed among the poor.

God our Heavenly Father has taken care that the *wants* of all persons who labour and lead a regular life shall be satisfied. These wants are few in number, and consist chiefly of *air*, *food*, *water*, *warmth*, and *clothing*. Some of these we receive freely, but others we receive only by working for them. Some persons are contented if they can work for the bare *necessaries* of life. If they can get only as much plain food and coarse clothing as will keep them alive, they are contented. If a person cannot, by all his industry, earn more than the bare necessaries of life, it is right to be contented; but if he can easily earn money to buy comfortable food, comfortable clothing, and other means of comfort and rational enjoyment, it is wrong to be contented with the bare necessaries of life.

It is the duty of every one to try to better their condition by skill and industry in any kind of lawful employment. Let him only take care to abstain from indulgence in vicious luxuries. One of the most vicious of luxuries is *spirits* or intoxicating liquors, which some people drink and make themselves intoxicated or drunk. When a person is in

this debased condition, his senses and intellect are gone, and he does not know what he is doing. He cannot walk, but staggers or rolls on the ground, and is a horrid spectacle to all who see him. Drunkenness is an odious vice, which leads to great misery and poverty, and the best way to avoid falling into it, is to abstain from tasting or using any spirits or intoxicating liquors. [Temperance societies are composed of persons who sign a pledge that they will totally abstain from making, buying, selling, or drinking as a beverage, any intoxicating liquor. It is supposed that more than a million of young people in the United States are growing up under this pledge, which inspires the hope of a great revolution in the habits of the next generation.]

OF CIVIL GOVERNMENT—EMBLEMS—AND RANKS.

The people who live in a country form a nation. We belong to the American nation, or the United States of America. There are two kinds of nations—those which are *barbarous*, and those which are *civilized*. In barbarous nations, the people have not comfortable houses, food, or clothing, and they live almost like beasts of the field. In civilized nations, there is a regular form of government; there are comfortable houses, and well-built towns; there are trades, commerce, and an abundance of every thing that can make life agreeable; the lands are well cultivated; and there are churches, schools, hospitals for the poor, and other valuable institutions. We live in a civilized country.

A regular form of government signifies a power which rules and directs the nation for the benefit of all. If there were no regular ruling power in a country, ignorant and evil-disposed persons would injure those who wished to live peacefully. Some are so wicked that they would take things from others by violence, in the same way that a large and strong dog will take a bone from a small and weak dog. It is the duty of a ruling power or government to prevent such wickedness.

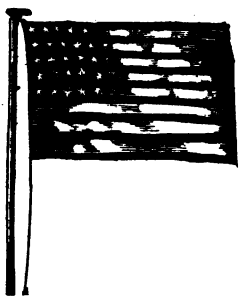
A ruling power is also necessary to prevent the public affairs of the people from falling into disorder. The ruling power directs what is to be done. If the people of one nation wish to communicate with the people of another nation about some matter of importance, it is the governments of the two nations that conduct and manage the communication.

Governments are of very different kinds. In some countries, one man is the ruler or sovereign, with the title of *king*. This is called a *monarchy*. In other countries, besides a king, there is also a body of men appointed by the people, to help in making the laws, and to check or control the acts of the king. This is called in Britain a *parliament*, and in other countries it passes by different names. The monarchy is then said to be a *limited* one. The government of Great Britain is a limited monarchy. In America and a few other countries, instead of a king, who at his death leaves his title to his son, there is a *president* who is chosen by the people, and rules only a short time. In such governments there is also a body or congress like a parliament, to help in making the laws, and to check the president. These governments are called *republics*. The United States of North America form a republic. Great Britain is now governed by Victoria, the queen.

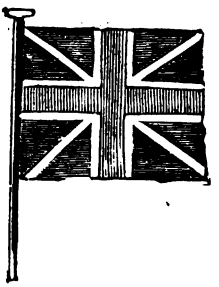
Whatever be the manner in which the ruling power is settled, it is the duty of that power to make *laws* to govern society, and to appoint courts of justice and magistrates to put the laws in force. It is the duty of every one to obey the laws, and to give respect to magistrates, who are appointed for our protection. In this way we shall live happily, and be at peace with all our neighbours.

Governments employ military, or armies of soldiers, to protect their country from the attacks of other nations, and to assist in keeping the laws from being broken. They also employ a navy, or ships with sailors, to execute their will in distant parts of the world. When a nation has its army and navy engaged in fighting with the army and navy of another nation, it is said to be at *war*. When a nation is not at war, it is at *peace*, and peace is the time of greatest happiness for the people.

Many nations and individuals are fond of using certain emblems or signs by which they may be known or distinguished. These are called heraldic emblems, because they are according to the rules of *heraldry*, which is a science for regulating the use of devices of this nature. The army and navy of every nation carry a particular kind of emblem, by which they may be readily distinguished. The emblem, which they carry is a *flag*. A flag is a large piece of cloth, coloured and marked, and hung at the top of a staff or pole. Here is a representation of the American and British flags.



American Flag.



British Flag.

When these flags are seen flying on a ship, castle, or places of any kind, it is at once known that that ship, castle, or place, belongs to the American or British government. Thus, every nation has its own flag, which it uses when necessary. Flags are usually called warlike emblems, because they are employed principally in matters connected with war.

Nations have likewise emblems which are used for peaceful and ornamental purposes, and which the people come to look upon with feelings of pride and pleasure. Thus, the common emblem of England is a *rose*, that of Scotland is a *thistle*, and that of Ireland is a *sprig of trefoil* or shamrock. These three are seen frequently painted or drawn in one group, like a bouquet of flowers, and are intended to

represent the union of England, Scotland and Ireland, in one government.

[The emblem of the United States of America is the spread eagle, as seen upon all American coins.

Certain families and individuals for the sake of distinction, use emblematic devices, called arms or *coats of arms.* These arms consist of various devices such as representations of crowns, shields, animals, men, and other objects, arranged in a particular manner, according to the rules of heraldry. Here is a representation of the arms of the king of England.

Coats of arms are used chiefly by persons of high rank. In Great Britain, and also in many other countries, there are persons who have titles of honour and are of a higher rank than others; all which distinctions have been given by the sovereign as rewards for merit, or for some other important cause, and are retained in the families. Persons who enjoy these honours are called *noblemen*, or *nobility*, and their titles are according to their degree of rank—*dukes*, *marquisses*, *viscounts*, *earls* and *barons* or *lords*.

Baronets and *knights* are of a rank below the nobility. [In America we recognize none of these titles, orders or ranks among individuals, and coats of arms are only used by the general and state governments, as in their official seals. It is the genius of our country to know no distinctions among men, except those founded upon knowledge and virtue.] After them is the class of persons usually called *gentlemen;* but it is difficult to say who belongs or who does not belong to this large class. Every man who conducts himself according to the rules for good manners, is deemed a gentleman in any country. It may depend on the behaviour and disposition of young persons, whether they will be admitted into society under this character.

Rank and title are not sure to confer happiness; a person in humble circumstances may be as happy as those whose lot it is to possess the highest distinctions.

He that is down need fear no fall,
  He that is low, no pride;
He that is humble ever shall
  Have God to be his guide.

SOCIAL ARRANGEMENTS.

In every civilized country, the people or inhabitants live in a *social condition*, or in an *organized society*. This means that the whole people conduct themselves according to regular laws; respect the rights, life, and property of each other, and all live in their appointed stations, in the exercise of acts of politeness and kindness. All this is much better than if people lived in an *unsocial condition*, each hating and trying to injure his neighbour. A com-

munity can never thrive that has not a proper social organization.

Many of the people of a country are connected with each other by relationship; they are *related* to each other. A boy or girl, for example, may have brothers and sisters, uncles, aunts, cousins, and other relatives, some of whom may be living in far distant places.

People are also connected with each other as *friends*, or as *acquaintances*. They feel pleasure in knowing and conversing with each other, and in keeping up a *correspondence* by means of letters. Many persons are, likewise, connected with each other in business.

The society which is formed in large towns and cities is more complete than the society in the country, where people live far apart from each other. In large towns and cities the inhabitants contrive many arrangements for their convenience and comfort. They cause the streets to be paved with flat stones for ease in walking, and they cause drains to be made to carry away all the rain and other water that would be injurious to health if it lay on the streets and became stagnant.

The streets are furnished with *gas lamps*, which burn at night, and give light to the passengers who are walking along the pavements. The gas which burns in the lamps is a kind of air, which is made from coal at gas-works, and is conveyed through the town in pipes laid below the ground.

The houses are supplied with *fresh water*, which is brought to them, also, in pipes laid below the ground. The water flows into the pipes at a river or fountain at the distance of several miles in the country, and comes all the way to the town, where it is distributed in smaller pipes to the different houses. By this means, few of the inhabitants of large towns have to carry any water. The drawing of water from wells, and carrying it to houses, is very toilsome, and causes a great loss of time.

The streets of towns are guarded by *police officers* or watchmen. It is the duty of these men to seize evil doers and take them before magistrates, who send them to pri-

son, where they are punished with confinement. It is a *disgrace* to be seized and put in prison for bad behaviour.

Towns are governed by a body of men called the *town-officers*. These persons are elected by the inhabitants to manage the public affairs of the place, and to watch over its interests. The members of the town-council and magistrates are sometimes called the *public authorities*, and we are bound to yield respect to their lawful orders.

Towns and cities contain *public buildings* and *private houses*. The public buildings are the churches or places of public worship; the hospitals for the sick and the poor; the prisons or jails for criminals; bridges, theatres, or places for public amusement; the schools or colleges where instruction is given to the young; houses for the courts of law; and all other buildings in which the people generally have an interest. Public buildings are often very elegantly built of polished stone.

Private houses are those in which private families dwell, and they usually stand close beside each other in rows, forming streets. The streets are distinguished from each other by names, as *High Street*, *Chesnut Street*, or *Broadway*. In some cases the rows of houses form squares, which are likewise distinguished by names, as *Washington Square*, *Franklin Square*, or *Centre Square*. In order to distinguish the houses in streets from each other, each house is numbered. The number is marked in figures on the door, or at the side of the door.

A good dwelling-house ought to be dry, or free from damp; its staircase well lighted; its apartments spacious, airy, and exposed to the light of the sun; its roof strong; its chimneys capable of carrying up the smoke; and, to be healthy, it must be kept in the most cleanly condition.

Every dwelling-house has *furniture* of some kind. Furniture consists of beds, tables, chairs, carpets, grates and fire-irons, trunks, chests of drawers, clocks, window curtains, and many other articles. Carpenters, cabinet makers, upholsterers, blacksmiths, and other artizans, make the furniture of dwelling-houses.

Some houses have gardens and small greens connected with them, and some have stables for holding horses.

Stables have neither windows nor chimneys, and they do not require furniture like that of a dwelling-house. Their furniture consists almost entirely of stalls for the horses standing in, and mangers from which they may eat their corn or hay.

Large towns contain many shops and warehouses for the sale of different kinds of goods, and quantities of these goods are sent to villages and houses in the country by *carriers* or porters, with carts and wagons drawn by horses. Carriers are a very useful class of men, and require to be well paid for the trouble they have in conveying merchandise from place to place.

Large and heavy goods are sometimes sent to distant places by boats on *canals*. Canals are channels of water resembling rivers; they have been made by digging the ground into the form of a long level trench or hollow, into which water has been put. Canal-boats are guided by a helm or rudder, like ships at sea, but they have no sails, and are usually drawn by horses.

In many towns *newspapers* are printed and published. A newspaper is a large sheet, very full of printed matter, which consists of *news*, or intelligence of events which have lately occurred in all parts of the world. The persons who conduct newspapers are called *editors;* they collect the news from distant quarters, and from every one who can tell them of any thing that has happened. They then cause the matter to be put in types, and printed. Some newspapers are published every day, and some only once a-week. By reading a newspaper, we learn what has occurred in the town in which we live, and in distant places.

Towns are connected with each other by *roads*. Roads are of great use in going from one place to another. If there were no roads, we should have to walk across rough fields, and have great difficulty in going on our way.. Roads are made with hard stones, and these being trodden upon and bruised, become smooth and pleasant for walking upon, or for the rolling of wheels. Some small roads are called *paths* or pathways; but large broad roads, which lead from one town to another, are called *highways*. A line of trees

on each side of a path or road leading to a house, makes an *avenue.*

When we *travel* upon highways, we come to gates which are placed across the road. These gates are called *turnpike gates* or *toll-bars*, because those who travel on horseback or in carriages, or who drive carts or wagons, have to pay a *toll* or small sum of money, for the liberty of going through the gateways. A man is placed to collect these sums, but he does not get the money for nothing. He pays a large sum of money every year to the persons who have the care of the roads, and these persons employ labourers to keep the roads in repair. The most of the money paid as toll, therefore, is expended on the roads.

Persons who go on a journey for a great distance through countries, are called *travellers.* These travellers depart from their homes, and perhaps do not return for many days or weeks. Close by highways, as well as in cities, towns, and villages, there are houses where travellers may find food and lodging for their money. These houses are called *hotels* or *inns*, and those who occupy them receive the name of innkeepers.

As it is very tiresome to walk on foot in travelling, some persons go on horseback, or in coaches or gigs; but as few people have a horse, or a coach, or a gig of their own, many go in *stage-coaches.* These vehicles are for the use of all who pay for them, and they can carry a number of persons at once. Travelling is also done in vehicles on railways, called cars, which are drawn by horses, or by locomotive engines which go by steam. [These steam engines are very often employed in carrying the mails, which are conveyed by steamboats upon the water, and by locomotives and railroads upon the land. These mails are established and supported by the government, for transporting letters and papers from persons in any part of the country to their correspondents in any other at however great a distance. In every city, town, village, and neighbourhood throughout the country, a Post Office will be found, having a Post Master whose duty it is to receive and transmit through the mails, all letters and papers deposited in his office, and to deliver whatever arrives by

mail at his office to the persons for whom it is intended. Sometimes the postage is prepaid by the person sending a letter, and is then stamped paid. But most frequently the person receiving a letter has to pay the postage, which is only a few cents. The expense of these numerous Post Offices, and of carrying the mails is very great, but the convenience and advantage to the people is so important and necessary, that the government is obliged to sustain the Post Office department at any cost, for in no other way could regular intercourse be kept up between distant portions of the country. Mails are also sent to foreign countries, chiefly by steamships, so that a correspondence may be carried on through the Post Office with any part of the world.] The distance which we go in a day is a *day's journey*, and often extends to 3 or 4 hundred miles.

FACULTIES AND EMOTIONS OF THE MIND.

I *know* that I am a human being, and have senses and intellect; that I can feel, move, wish, think, and speak. I know my name, the name of the place where I was born, the name of the country of which I am a native, and the name of the place where I now am. I know that I am a young person, and have many things to learn.

I can *comprehend* or *understand* what is said to me. If I be told by my teacher to stand up, I understand that he wishes me to rise from my seat. When any person asks me what is my name, I understand what is wanted; I tell my name. If my parents say to me, you must not go out to play to-day because it is wet, I understand that they wish me to stay in the house, and therefore do not go out. I can understand why a house has a door and windows, or why people should wear light clothing in summer and warm clothing in winter.

I can *reflect* or *think*, on what I have seen, or what is said to me. I know by experience that fire burns. If any person should tell me to put my hand into the fire, I would reflect or think on what was said, and answer that I could not put my hand in the fire without having it burnt, and

therefore would not do it, because burning was very painful and injurious. I can also reflect on the danger of going into deep water, where I might be drowned. I can reflect on advices which have been given me. I can reflect on any question that is put to me before I answer it. I can reflect on the consequences of bad behaviour. If a coach were about to run over me, I should instantly reflect on my danger, and decide on going out of its way.

I can reflect on the reason for doing things, or the *design* in doing them. The eyes were designed to see and the legs to walk; they fulfil this design. The design in sending me to school was that I should learn to read; if I do not learn to read, I do not fulfil the design. A boy went upon the ice to slide, but the ice was too thin and could not bear him, and so he sank and was drowned. The design of the boy was to slide, not to be drowned. The drowning was an accident, and was caused by the boy's imprudence in not reflecting. The word *intention* is often used for design.

I can understand what is meant by employing *means* to do a thing. If I wish to have my cap, which is hanging on a peg on the wall, I must employ means to get it; it will not come to me itself, because it is an inanimate object, and cannot move. The means I employ are my own legs in walking to it, and my own hands in taking it down. Builders reach the top of houses by means of ladders. Goods are carried from place to place by means of carts and horses. A girl sews by means of a needle and a thread. Children are supported by means of their parents working for them, and are taught by means of books and teachers.

I know what it is to *hope*, or to *expect*, that an event will take place. I can hope that, if my life be spared, I shall grow tall and strong, and be able to be useful among my fellow-creatures. I can hope that my friends will be pleased with my conduct. If I suffer any misfortune, I hope to be able to endure it with patience. If I be successful in life, I hope I shall not be vain or proud.

I know what is meant by *order* and *disorder*. Order is proper arrangement; disorder is improper arrangement. A

row of books on a shelf stand in order, but a heap of books on the floor lie in disorder. If my hair be combed, it is in order; if it be not combed or brushed, it will be in a state of confusion or disorder. A company of soldiers stand in proper order in an even row. By this arrangement they can readily defend themselves and be active in their movements; if they stood in disorder like a mob, they could not properly defend themselves, and would be easily overcome.

I know what it is to feel the emotion of *fear* or dread. I fear to do evil; such as to lie, to steal, or to injure my neighbour. I have three reasons for fearing to do these things—I fear to incur the anger of God, I fear to lose my good character among men, and I fear the stings of my own *conscience*. There is something within me which feels unhappy or vexed when I have done any wrong. This thing which feels is my *conscience*. My conscience feels *remorse*. All fear of this kind is proper.

There is a wrong kind of fear, which I will try to despise. I mean the fear of things which are not worthy of fear. This is called a *false fear*, or false terror. Some persons feel a fear in going into a dark room at night, but I have no terror of this kind. I know that there is nothing in the dark which is not in the light. Darkness and lightness make no difference in things, either without the house or within. Some persons also are *afraid* to do what is right, for fear of being laughed at; but I hope I shall never feel any fear of this kind. I hope to be always able to do my duty in acting correctly, without any fear of what people will say or think.

Some persons boast of their *courage;* they say they have no fear in going into danger. It is wrong to boast of doing any thing, and it is still worse to boast of not fearing danger. Every one should be *cautious*, or feel *caution* in meeting dangers. It is true courage to meet dangers in a good cause; but it is *fool-hardiness* to seek dangers, or to go into dangers in a bad cause.

I can *distinguish* one thing from another by comparison, and by using my senses. I can distinguish a circle from an oval, or a square from a parallelogram. If any one

should *doubt* this, I could *prove* the truth of what I said, by drawing and naming these figures. I can also distinguish differences in colours and tints. I can distinguish that a thing is what it is—that a man is a man, and that a hat is a hat. If I see a hat lying before me, nothing can make me believe that it is a coat, because I know that my sense of sight and my reflection do not deceive me. If a person were to point to a horse and say, there is a cow, I know by my sense of sight and my knowledge of these animals that he would not be speaking the truth.

I can *compare* one thing with another, and *decide* or *judge* which is best. I can compare my knife with the knife of another boy, and tell the *difference* between the two. I can compare my book with another book, and decide which is the larger. I can make a *comparison* between my condition and the condition of a poor houseless child, and decide that my condition is preferable. I can compare the distance which I have to walk to school, with the distance which another scholar has to walk, and I can tell which distance is the longer, and which the shorter. I can compare three things together, and distinguish which is *good*, which is *better*, and which is *best*; I can also decide which is *bad*, which is *worse*, and which is *worst*.

I know the difference between a *cause* and an *effect*. When the wind blows very hard, trees are blown down, and fall on the ground; the blowing of the wind is the cause, and the falling of the trees the effect. If any one were to say to me that the trees fell because a cat was heard to mew, I should know that that could not be the case. If I strike a nail on the head with a hammer, and make it sink into a piece of wood, I know that the stroke of the hammer is the cause of the sinking of the nail. God is the great first cause, and sustains all by his mercy and goodness.

I can exercise my *imagination*. I can *imagine* the appearance of a thing if it were different from what it is. I know that I have a light-coloured face, but I can imagine what my face would be like if it were covered with soot; I can imagine that it would be very dark. When I am hungry, I can imagine what pleasure I should have in

eating. If I were to become ill, I can imagine how anxious my parents would be to have me well again. If I were to steal or lie, I can imagine how every body would despise me, and how unhappy I should be. I can imagine to myself my father and my mother, although they be absent. I can imagine the pleasure of walking in a field or in a garden in a beautiful day, and imagine the pain of walking barefooted amidst snow in the cold of winter. All this would be the exercise of my *imagination.*

I can exercise my *memory.* I can *remember* or *recollect.* I can recollect rising from bed this morning, and putting on my clothes. I can remember when I was sent to school. I have a recollection of persons who are dead. I can remember a story which was told to me, a pain which I formerly felt, and a pleasure I experienced long ago.

[I can remember many moral lessons which have been taught me, some of which I hope never to forget. I have been taught that I must be good, if I would ever be great, or happy, or useful. Learning itself would be a curse instead of a blessing, if I ever became depraved and wicked. I ought to love goodness, not only because of its rewards here and hereafter, but for its own sake. I ought to love the truth because it is the truth, and therefore lovely in itself; and I should hate a lie because it is a lie, and therefore hateful. And hence I ought to speak the truth, whatever it may cost me, and never depart from it, whether I gain or lose by the truth. I have learned that "though the truth may be *blamed,* it can never be *shamed,*" while falsehood, sooner or later, brings shame and contempt. And I recollect that I have been told, that the only way to be happy is to retain my own self-respect, and this I can only do by always speaking the truth, and always trying to do right. May I never forget these good and useful lessons.]

THE END.

TREASURY

OF

KNOWLEDGE.

PART II.

PRACTICAL LESSONS

ON

COMMON OBJECTS.

CHAMBERS' EDUCATIONAL COURSE.

Entered according to Act of Congress, in the year 1846, by
SORIN & BALL,
in the Clerk's Office of the District Court of the Eastern District of Pennsylvania.

INTRODUCTORY OBSERVATIONS

BY THE

AMERICAN EDITOR.

In the compiler's preface which follows, it will appear with what purpose the London edition of this work was prepared, and the design contemplated by the society, at whose instance it was published, is also distinctly stated. In adapting it to the common schools of the United States, very considerable alterations have been judged necessary, and numerous additions have been made, especially in reference to those objects of special interest to American youth. Those subjects which, however familiar in Great Britain, are not common in this country, and would hence be neither interesting nor intelligible, have been omitted, or rather substituted by other articles of more familiar and practical utility.

In many of our schools, a kindred work, entitled "Conversations on Common Things," has long been in use, and is highly estimated. But the present volume will be found to possess higher claims in many respects, apart from its being more scientific and extensive in its scope and details. Even viewed in the light of a sequel to that work, it would be regarded worthy of introduction into the schools; while as a book for teachers, to qualify themselves to give minute and accurate information to their pupils, touching the common objects in nature and art, this volume is greatly to be preferred.

The catechetical questions, which are both analytical and critical, will be found sufficiently numerous to constrain the pupil to think, and to understand every part of this book, if he

would prepare himself for such an examination as is here contemplated. To the teacher, they will furnish very great facilities both for acquiring and imparting knowledge on these common but important subjects. Indeed it will be difficult to find a work of so small size, condensing so much useful and practical instruction on such a variety of topics, many of which will singly furnish a theme for an oral lecture, or protracted conversation of itself. Its introduction into our common schools is warmly commended, from a conviction of both its need and utility, and for which purpose no pains has been spared in preparing it.

THE AMERICAN EDITOR.

PREFACE.

The following work has been prepared at the request and under the superintendence of the Committee of the Home and Colonial Infant School Society.

The end proposed was the communication of such knowledge as would be desirable for a teacher to possess before giving a lesson on any common object, and only such facts have been stated as it is requisite they should know. It may not be out of place to guard teachers against the supposition that they are to bring before the children all the knowledge here communicated; the aim is rather to put them in possession of that confidence which is essential to the giving a really good lesson—the confidence that they are acquainted with their subject, and are prepared to satisfy the desire for information which an examination of any of the objects may awaken in the minds of their pupils.

The objects described are contained in a box arranged for the use of schools according to instructions given by the Committee of the Society.

Although the classification of the descriptions is imperfect, it is perhaps the least objectionable that could be made.

The articles are described as briefly as is consistent with clearness, so that the size and price of the work might be as small as possible.

A list of some of the works consulted by the compiler is annexed:—

Ure's Dictionary of Arts and Manufactures.

Lardner's Cyclopædia—Manufactures in Metals.

Penny Cyclopædia.

Encyclopædia Britannica.

Partington's Cyclopædia.
Burnett's Outlines of Botany.
Burnett's Useful Plants.
Lindley's Flora Medica.
Smith's English Botany.
Loudon's Arboretum Britannicum.
Loudon's Encyclopædia of Agriculture.
Thompson's Dispensatory.
Pereira's Materia Medica.
Library of Entertaining Knowledge—Vegetable Substances.
Transactions of the Society of Arts.
Turner's Chemistry.
Graham's Chemistry.
Knight's Weekly Volume—Textile Manufactures; and British Manufactures.
Taylor's Handbook of Silk and Cotton Manufacture.
Owen's Lectures on the Invertebrate Animals.
Fleming's Molluscous Animals.

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OBJECTS

DERIVED FROM

THE MINERAL KINGDOM.

THE METALS.

INTRODUCTION.—The metals form a class of bodies belonging to the mineral kingdom. They are distinguished from minerals in general, not by any one character in particular, but by several taken together; [usually their weight, lustre, fusibility, and power of conducting electricity, are enumerated. The metals are not usually found pure in nature, but in the state of ore, in which they are combined with various minerals, and from which they are separated by heat, the metal being melted, and while in a liquid state in suitable furnaces, it is suffered to flow off from the earths or stones with which it was previously united in the ore. In some instances, metals are combined with sulphur and other volatile materials, which are driven off by heat, while the pure metal remains. The art of refining metals is included in the science of Metallurgy.]

They all possess a *peculiar* brightness, very different, for instance, from that of glass, or wax, or varnish;* but we must not therefore imagine that all bodies that possess this peculiar brightness or lustre are metals, for many other minerals have it. [What is called the rusting or tarnishing of a metal, is occasioned by the union of oxygen

* We are apt to consider lead, and some other metals, as not possessed of this brightness, from the circumstance of their tarnishing on the surface, when exposed to the action of the air; if, however, the tarnish is removed by scraping or polishing in any way, their brightness is immediately restored.

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1. How are metals distinguished from other minerals?

with the metal on its surface; so that an oxide is another name for rust. Silver, platinum, and gold are not liable to this change, and therefore preferred for making plate and coin.]

If a sheet of polished metal be held before the fire or a candle, the heat from the fire or the light from the candle, instead of passing through the metal, as they would partly through a sheet of glass, or sinking into it, as they would into a rough black board, are thrown back again, or *reflected:* if, instead of holding the metal straight before the fire, we hold it at an angle or slantingly, the heat, instead of being thrown back, will be thrown in another direction; this will be easily proved if we stand by the side of the fire-place, so that we cannot see the fire, and get another person to hold the sheet of metal, moving it until we see the light of the fire on it, when we shall feel the heat also.

This simple experiment, which may be performed with any sheet of *polished* metal, as a bright shovel or the under surface of a large saucepan lid, proves that the light and the heat of a fire, on striking or falling on a polished metallic surface, are thrown off from it, or, in other words, *reflected;* and therefore metals are said to be *good reflectors of heat and light.* Many of the most important uses of metals depend on this property; for instance—metals are used to make the reflectors placed in carriage lamps, which throw the light in the direction required. Light-houses on the sea-shore are usually provided with metallic reflectors, so placed as to throw out to sea the light that would otherwise pass inland. In our kitchens, screens of bright tinned plate are placed before meat that is being roasted, in order that the heat from the fire may be reflected by them back upon the meat instead of passing into the room.

When metals are required to reflect heat or light in any direction, they should be brightly polished, as it is only when in this state that they reflect well.

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2. How does their surface become tarnished?
3. What of the reflection of heat and light?
4. Of what use is this property of metals?

If we make a bar or rod of metal, as for instance the poker, red-hot at one part, we shall find that we are not able to hold it in the hand nearer to the red-hot part than one foot and a half or two feet; if we make a stick of wood or charcoal red-hot, we can hold it readily within an inch of the heated part without being burnt. This remarkable difference arises from the metal conveying the heat to the hand with great quickness and facility, whilst the wood and charcoal do not possess this power of conducting heat.

Metals are, in fact, distinguished among solid bodies by the ease and rapidity with which heat passes along them, and from this circumstance they are said to be good *conductors* of heat; whereas wood and charcoal are bad conductors of heat. It is from possessing this property that metals feel cold to the touch, because they carry away the heat of the skin very rapidly, and not (as is often wrongly supposed) because they are really colder than other bodies: a spoon or any other metallic substance that has been lying some time on a table, must necessarily be of the same heat as the table, both having been exposed to the same air and warmth; if, however, the hot hand is placed on the spoon, the latter feels cold, because it carries away the heat from the hand very fast; on the contrary, the table does not feel cold, because it does not possess the power of conducting the heat so rapidly.

Not only do metals possess the power of conducting heat, they also are distinguished as conductors of another principle called Electricity, or, when it occurs on a large scale in nature, Lightning. It was from a knowledge of this fact that lightning conductors for protecting buildings and ships were first devised. A lightning conductor consists of a rod of metal, higher than the building or mast to which it is attached, and carried some depth into the earth or the sea; the use of this rod is, as its name implies, to conduct the electric fluid: being higher than the building to which it is affixed it attracts the lightning, and

5. What example is cited of the *conducting* power of metals?
6. Explain the difference to the touch, between metals, wood, &c.
7. Of what else, besides heat, are metals good conductors?

conveys it into the ground or into the sea. The metal allows the electricity to pass freely along it, and hence it is not injured by it; the brick and stone work of a house do not allow a free passage for the lightning, and consequently, if struck by it, are destroyed.

Of all metals, copper is by far the best conductor of electricity, and should therefore always be used for this purpose. [And hence copper wires are used in the electro-magnetic telegraph, which is now becoming generally adopted in our country as the means of communicating intelligence between distant places.]

Some few of the metals are brittle, so much so, that if struck with a hammer they break into small pieces; this is the case with antimony and bismuth. The greater number, however, on being beaten with hammers spread out into thin leaves;—this property is called *malleability*, and those metals capable of being beaten out into the thinnest leaves or sheets are said to be the most *malleable*.

Of all the metals, gold possesses this property in the highest degree; it can be beaten until the leaves are only the 282,000th of an inch in thickness.

Malleable is derived from the Latin word *malleus*, a hammer, from whence comes our English word mallet.

Another property possessed by several of the metals is capability of being drawn out into thin wires: this property is called *ductility*. Of all metals, gold is the most ductile, or, in other words, it can be drawn out into thinner wires than any other metal. The mode adopted for drawing out metals into wires is, first, to form the metal into a bar or cylinder: this bar is drawn by machinery through a hole smaller than itself, and is, of course, lessened in size and increased in length by the operation; it is then drawn through a still smaller hole; again through one still less, and so on until the wire is of the size required.

The strength of wires does not, as would be supposed, correspond with the ductility of the metals of which they

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8. What useful inventions have resulted from this fact?
9. What of malleability and its opposite, with examples?
10. Define ductility, and illustrate it by examples.

are formed; by far the most tenacious metal is iron, although in ductility it is surpassed by gold, silver, and platina.

The strength or tenacity of metals is easily ascertained, by taking the same sized wires of the various metals, and trying what weight they will bear without breaking.

We are apt to think that all the metals must be very heavy bodies; the greater number of them are so, but not all; there are some (though these are not common) that, being lighter than water, float on its surface. Others, again, as gold and platina, are the heaviest bodies in nature; the latter is more than 21 times heavier than water, and gold more than 19 times. Iron, tin, and zinc are between seven and eight times the weight of water.

All the metals are capable of being melted by heat, that is, they are all fusible: they vary, however, very greatly in their degree of fusibility; the heat that always naturally exists in this country is sufficient to melt one of them, mercury. Near the north pole, however, the temperature is not sufficiently great to melt this metal, and it is, of course, there in a solid state. Some metals fuse below a red heat, as lead, tin, and zinc. The other common metals do not melt until they are heated above a red heat. It is a singular fact, that when two metals are mixed together, the resulting compound, which is called an *alloy*, melts at a much less heat than either of the two metals of which it is formed would have done separately. For this reason solder, which is an alloy formed of lead and tin, is used by plumbers for uniting pipes together, as it melts at a less heat than lead, and is consequently more manageable.

Not only are all the metals fusible, but some are even volatile, that is, on being heated they fly off in the form of vapour. The common metals that possess this property are mercury and zinc.

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11. Explain tenacity, and how tested.
12. Name the comparative weight of metals.
13. What of the relative fusibility of metals?
14. Which of the metals are volatile?

The metals vary much in hardness; some of the uncommon ones are as soft as wax, and can be moulded by the hand. Lead can be scratched by the nail; copper, gold, and silver are harder; zinc and iron still more so.

The metals are supposed to be simple substances, that is, they are not compounds or mixtures of several bodies. We know glass to be a compound body, because we can make it by mixing several things together, and melting them; or we can separate the various things of which it is made: but we suppose iron and all the other metals to be simple substances, because we cannot make them, nor can we separate any thing from them. Metals are usually found not pure, but mixed with various substances, and in this state they usually look like stones, and are called ores. Thus, the minerals from which iron is obtained are called iron ores. Lead is procured from lead ore, &c. &c. [There are, in all, forty-one metals, but some of them are rare and of little use. A few only are sufficiently important to be separately noticed, such as platinum, gold, silver, copper, iron, tin, lead, zinc, and quicksilver.

Platinum.—Platinum, from its durability and hardness, would be of immense utility in the arts, were it not too expensive to be generally used. Chemical vessels are made of it, and it is employed for pointing gold pens. Of late, it has been used for coating copper vessels in Europe, instead of tin. It is heavier and more costly than gold. Mines are found in Russia, Spain, and South America.]

Lead.—Lead is a metal found principally, in England, in the Mendip Hills of Somerset, and in the peak of Derbyshire, not in its metallic state, but as an ore, containing a large quantity of sulphur. This ore is called galena, or lead glance. [Lead mines are wrought in several parts of the United States; but those most productive are on Missouri and Fever rivers, and yield ten millions of pounds annually.] The metal is obtained from the galena by first heating it strongly, or roasting it, as it is termed, in order

15. Why are metals called simple substances or elements?
16. Describe platinum, its locality and its uses.
17. Where is lead ore found in quantity?

to burn away the sulphur. The whole is then melted, when the lead, being heaviest, sinks to the bottom, leaving the impurities on the surface. It is then allowed to run into moulds, each of which holds about 150lbs. The masses of lead thus obtained are termed pigs, or pig-lead. It is a bluish-gray colour, very brilliant when first melted or scraped, but the surface rapidly tarnishes when exposed to the air or to water. The use of lead, as a material for making water-pipes, and for lining cisterns, depends partly on the forming of this rust or tarnish, for the metal itself is poisonous; but it does not render the water unwholesome, as the tarnish on the surface prevents any further action of the water on the metal. It is the softest of the common metals, being readily cut with a knife, or even scratched by the finger nail. When rubbed on paper a portion is left, causing a bluish-gray stain. It is readily melted, fusing before it is heated to redness, and it is one of the most inelastic metals, remaining in any position in which it is bent. It is this very softness, and the ease with which it is melted, that render lead so valuable to man. It requires little labour to work it; it is easily cast into any shape, consequently it is much used. Sheet-lead is made either by casting the melted metal in sand, or by rolling it into sheets, when solid, between large rollers. It is in great use for covering the gutters or roofs of houses and other buildings; for lining cisterns, coffins, making water-pipes, &c., the ease with which the metal is cut, and the flexibility it possesses, enabling the workers to bend and adapt it to any object it is desired to cover.

The Chinese have taken advantage of the ready fusibility of lead to form the thin lead with which they line their tea-chests. A quantity of the melted metal is poured on a flat stone, and before it cools another is laid on it, which presses the lead into a thin sheet. Bullets used by soldiers are made by casting the melted metal in moulds, whilst the lead shot employed by sportsmen are made by melting the lead with a small quantity of another metal,

18. Describe the process of separating lead from its ore.
19. What are the uses of this metal?
20. For what other purposes is it used, and how?

called arsenic, to render it harder. When melted, this mixture, or alloy, is poured into an iron or copper frame pierced with holes like a cullender, through which it streams in a shower, dividing into drops, which fall into cold water; and, in order that the lead may be somewhat cooled before it reaches the water, it is allowed to fall from a great height, the shot factories being built for this reason about 100 feet high. Alloyed with one-sixteenth part of the metal called antimony, the use of which is to harden it considerably, lead forms the substance of which the types or letters used in printing books are cast. Melted with tin, it forms the substance used by plumbers for uniting together pieces of metal, and which is called solder. When two metals are melted together, the compound formed is much more easily fused than either of the metals separately would be; therefore the hot iron of the plumber will melt the solder whilst there is no risk of his melting the lead or other metal he has to join. In weight lead exceeds most of the common metals; it is eleven-and-a-half times heavier than water: being so very heavy, it is often employed for clock-weights, &c.

Its ductility and tenacity are exceedingly small; it cannot be drawn into wires less than one-twelfth of an inch in diameter, and they will not support more than two 20lbs. To bear one cwt. a wire of lead would be required two inches and a half in diameter. Lead, however, can be beaten out into very thin leaves; but they possess but little strength. Use is made of the capability of lead to be drawn out in making pipes. A thick rod of lead is cast with a hole down the middle, the size of the bore of the pipe required; in this hole an iron rod is placed to keep it from closing, and the lead is then lessened in size and increased in length by being drawn by a machine through grooves in rollers gradually decreasing in size. When the pipe is sufficiently small, the iron wire is withdrawn. [To obviate the poisonous properties of lead pipes, they may be coated with tin by rubbing heated lead with melted tin,

21. What of its ductility and tenacity?
22. How are lead pipes made and tinned?

using turpentine or resin as a flux. The tin adheres to the lead, and it may afterwards be drawn out into pipes as before.]

When kept melted for any length of time, lead rapidly forms a dross on the surface: this substance is litharge, which is much used in glazing earthenware, and in making flint-glass, to which it gives great transparency and clearness, and lessens its liability to crack.

Red-lead is another preparation of this metal; it is also used by glass-makers, and by painters as a colour. White-lead is prepared by corroding lead with the vapour of vinegar. It is used in very large quantity to form paint. All these preparations of lead are extremely poisonous, giving to persons who use them paralytic diseases, and a dreadful complaint called painters' cholic. Besides painters, those who work with the metal, and are called plumbers, from the Latin name of lead (plumbum), are liable to these disorders.

Black-lead is a mineral substance that does not contain any portion of lead. [It is called plumbago, and is a carburet of iron, out of which crayons and pencils are made.]

Copper.—The most important and valuable ore of copper is that termed copper pyrites, in which the metal is united to sulphur and iron. It is found in very large quantity in Cornwall, Devonshire, and Anglesea, [in Britain, and also in North America, especially near Lake Superior. But there are no copper mines wrought in the United States.]

The copper is obtained from this ore by a very complicated process, during which the ore is heated to redness (or roasted) many times, in order to drive off the sulphur, and the earthy impurities are separated by their being melted away. As thus obtained, copper is of a reddish colour; it has a nauseous taste, and, when rubbed, a disagreeable smell. It is one of the most malleable of the metals, capable of being beaten or rolled into very thin

23. Name the preparations of lead, and their properties?
24. What of black-lead pencils, so called?
25. Where is copper ore found?
26. Describe the properties of copper, and its uses.

leaves, and it is possessed of very considerable hardness. It is on its malleability that its great use depends. When heated, it is rolled into sheets between cast-iron rollers, which are, after each rolling, placed nearer together so as to lessen the thickness of the sheet. These sheets are used for protecting the parts of a vessel that are under water, for which purpose the copper is well fitted by its hardness. Sheets of copper are also used for making copper money. Round pieces of the size of the coin required are cut or punched out of the sheet, and then by a powerful engine are stamped with the design. Sheet copper is much used by the engraver; it is not so exceedingly hard but that his steel tools will act upon it, and yet is sufficiently so for a large number of prints to be taken from it without injury to the design.

Copper is remarkable for its great ductility and tenacity; it can be drawn out into wire smaller than those of any other common metal, except gold, silver, or iron; and in strength copper wire is superior to all, except that of iron. The use of copper wire for bells is well known, and no metal could well supply its place; iron is stronger, but then it rusts, which copper does not if not wetted. Copper is of all metals the most sounding or sonorous when struck. This property, perhaps, depends partly on its elasticity, which is very considerable. In consequence of this property, copper, when properly prepared, or some mixture of it with other metals, is always selected to form musical instruments. Among the other uses to which copper is applied is that of making utensils for cooking; but it should never be so employed, being one of the most poisonous of the metals, and readily acted on, and in part dissolved, by any substances containing acids, as vinegar or fruit, when the portion dissolved renders the whole poisonous. Many lives have been lost by persons eating food that has been left standing in copper vessels. [They should be perfectly lined with tin.]

At a bright red heat copper melts, and then may be

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27. For what other properties is it valuable?
28. What precautions are necessary?

readily alloyed with other metals. Some of the compounds thus formed are more valuable than even copper itself. When 80 parts of copper are mixed with 20 parts of a metal called zinc, and melted together, brass is formed, an alloy of extreme value. The colour varies with the proportions of copper it contains; its value depends on its being cheaper and more easily melted than copper, and though not so hard, yet as it does not rust when exposed to the air, it is used for the making of engines, clocks, and wheels of watches. So readily and cheaply is it worked in consequence of its softness, fusibility, and ductility, that it is employed to a great extent for domestic purposes, as for pins, candlesticks, &c.

Bronze is an alloy of copper with a small quantity of tin; it is extremely hard, and was used by the ancient Romans to form cutting instruments and weapons, as iron was not known to them. In the Scripture we find constant references to its use: it is there, however, termed brass, and the articles made of it are called brazen. [It is now very extensively manufactured in France, in the construction of various articles for use and ornament.]

The compound of which bells are made is formed of copper alloyed with tin and other metals.

The German silver now used contains copper, which is dissolved if the spoons, &c. made of it are left in vinegar or pickles, rendering the whole unwholesome.

[Gold is not only valuable for its scarcity, but for its malleability, ductility, tenacity, and unalterability, by reason of which properties it is employed in various ways for use and ornament, excelling as it does in some of these respects every other known material. It is found in Mexico, South America; Russia, and some other parts of Europe; in Africa, and occasionally in the United States. It exists chiefly in scales, grains, and lumps, though sometimes in rocky beds, and in the state of ore. It is chiefly gathered

29. What is brass, how made, and its uses?
30. What other alloy of copper is named?
31. What renders gold so valuable?
32. Where found, and for what purposes employed?

by washing or picking in the sand. Lumps of virgin gold have been found, occasionally weighing several pounds. In England $300,000 have been annually converted into gold leaf; and the quantity of gold coined at the London mint in 1829, amounted to 200 millions of dollars. At present the gold mines wrought in various countries scarcely yield the expense of working them; even those of South America only producing four millions of dollars annually, though very numerous and most productive there.]

SILVER.—Silver is a valuable or precious metal that is found in very considerable quantity in the central countries of America, viz. Chili and Peru. In the mines, which usually are in the mountainous districts, the silver occurs native or in the metallic state; and being nearly pure, it is readily separated from the substances it is united with by roasting it, to drive off any small quantities of sulphur present, and then mixing the whole in mercury, which dissolves the silver and leaves the impurities. The mercury is then evaporated by heat, and is collected to be used again, whilst the silver, not being volatile, remains in the vessel. The fumes of the mercury, when thus heated, are very destructive to the lives of the workmen employed. In almost all the lead ores of this country there is a small proportion of silver, and in many the quantity is sufficient to repay the cost of extracting it.

In appearance, silver is one of the most beautiful of the metals, it being more brilliantly white than any other; and it is capable of being more highly polished than any, except steel. It is quite destitute of any taste or smell, and is not in the slightest degree changed or acted upon by water, moisture, or pure air. It is these circumstances that render silver so highly prized as a material for making utensils for domestic use. Its beautiful appearance and high polish recommend it to the eye; and as it is not acted upon, like copper, by our food, or by any acid, such as

33. Whence is silver obtained, and how?
34. Describe its properties and uses.

vinegar, it does not render our victuals impure or poisonous; and as it is without taste or smell, it cannot communicate either.

The value of silver, and its occurring in the earth in a metallic form, not requiring any great skill to extract it, are the causes that it was one of the metals first used by man; and we have records of its being appreciated in the earliest times.

Silver can be beaten or rolled out into thinner leaves than any other metal, with the exception of gold, and its use to man depends, in a very great degree, upon this property. Before being made into such articles as cups, candlesticks, &c., silver is rolled into thin sheets, which are cut the required shape, and soldered together at the edges. Sheets of silver, cut into circular pieces, and stamped with a device, are used in almost all civilized countries as coins or money; and, from the high price of silver, these are used for greater amounts than coins of copper. Silver, however, when quite pure, is too soft for the purpose of making money, therefore it is usually alloyed with about one-twelfth of copper.

The value of silver prevents its being much employed by any but rich persons; but by a process termed plating, articles are formed that possess all the advantages of silver, and are not more than one-sixth of its cost. Plating is the covering of another metal with a surface of silver. If a sheet of copper is required with a face of silver, it is formed in this manner: A thick, stout bar of copper is taken, and on it is laid a thin sheet of silver. They are bound together by wire, and heated so as to make them unite. The bar thus formed is rolled into a large sheet, which still has a thin covering of silver, and may be used in the same manner as a sheet of silver. Articles that, from the shape, cannot be covered with silver in this manner, are rubbed over with some silver dissolved in mercury; the latter is then driven off by heat, and the silver remains covering the article.

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35. What of sheets of silver, and why alloyed?
36. Describe the art of plating.

Silver is one of the most ductile and tenacious metals: it is therefore much used in the form of wire, and from its strength, as well as its unchanging beauty and value, is formed into chains for watch-guards, &c. These, again, are frequently covered with gold, or gilt, as it is termed.

Besides the above uses, silver supplies a most valuable caustic for the use of surgeons; and the same preparation of it is made into marking-ink.

N.B. Plating of articles, as spoons, forks, ornaments, &c. of an irregular shape, is now done by the aid of galvanism, a kind of electricity.

[TIN is always found in the state of ore, and the chief mines are those of Cornwall, in England, where it is obtained with copper and lead, and yield about nine millions of pounds of tin annually. It is chiefly employed in the form of sheet tin, which is made by dipping plates of iron into melted tin, when it is wrought into various utensils, and used for covering roofs. It enters into the composition of metals, forming pewter, bronze, solder, &c., and is very useful in various arts and manufactures.]

MERCURY, or QUICKSILVER.—Mercury is found united with sulphur in many parts of the earth, but the largest mines of it are in Spain and Peru. One mine alone in Spain employs about 1000 persons in working it. The mercury is obtained from the sulphur with which it is united, by placing the ore in close iron or earthen vessels along with iron or lime. The vessels are then heated to redness, and the sulphur unites with the lime or iron, whilst the mercury is set free, and, being volatile, passes off in vapours, which are cooled, when they condense into the fluid metal. Mercury is a metal of a very brilliant lustre, and a white colour, resembling silver. It is the only metal that is melted by the warmth of our climate. Near the poles, and even in some parts of Siberia, in win-

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37. What of tin, and its various uses?
38. Where and how is quicksilver obtained?
39. Describe its nature, peculiarities, and uses.

ter, it is solid, but when brought to warmer climates it melts; in this country it is always fluid. A small drop of mercury placed on a flat surface, retains a round form, for it does not adhere or stick to those objects with which it is placed in contact—hence it readily rolls about if the surface on which it be is at all inclined, and this power of rolling readily over sloping surfaces, and its colour, have gained for it the name of quicksilver. It is very easily divided—a drop allowed to fall on the table separates into an immense number of little globules, each of which retains its round form, and runs about readily if the surface of the table be not quite level. Mercury is quite free from any taste or smell, and in the state of a metal is not poisonous. The use of Mercury in the arts depends partly on its being a volatile substance, and on the readiness with which it combines with other metals, forming compounds termed amalgams. Silver is extracted from its ore by being placed in contact with mercury, with which it unites and becomes dissolved; the compound is then heated strongly, and the mercury is driven off in vapour and is collected for future use, whilst the silver remains behind. It is used in the same manner in silvering or plating small objects. (See SILVER.) It unites readily with the common metals, tin and lead; advantage is taken of this circumstance in forming looking-glasses, which are backed with a compound of tin and mercury. A small piece of glass may be easily made into a looking-glass, by taking a piece of tinfoil (which is merely tin beat out into thin leaves); on this, which must be very smooth, some mercury is to be spread quite evenly, and both covered by a piece of very smooth paper; the glass is then to be laid upon the paper, and pressed down, whilst the latter is pulled steadily away, when the glass and the mercury will come into contact, and if the operation has been skilfully conducted, there will be no air bubbles, as they are drawn out by the paper; if a weight is then put on the glass, so as to press out the excess of mercury, a very tolerable

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40. What of its amalgams, and their use?
41. How are looking-glasses made?

mirror is the result. Large glasses are made on exactly the same principle. The weight of mercury is very great —it is thirteen times heavier than water; this circumstance, together with its being unchanged by the air, and its fluid state, render it of great use in making philosophical instruments.

It is also used in medicine when combined with other substances. One very useful preparation of mercury is calomel, and it also yields corrosive sublimate, a medicine of very poisonous properties, which is much used for preventing the dry rot in wood and cordage.

Pewter.—Pewter is an alloy formed of tin, copper, antimony, lead, and different metals, according to the use to which it is to be applied. The common pewter dishes and measures for beer are made of tin, with one-twentieth of its weight of copper melted together. The uses of pewter depend upon a quality common to all mixtures of metals, that they melt more easily than simple metals; pewter melts readily, and is without trouble cast into any required shape. When cold it is inelastic, and will bend to some considerable extent without cracking; thus it is advantageously employed for measures which are exposed to great violence, as, if it is knocked out of shape, it can be restored by beating. Compared with copper and other metals that might be employed, it is cheap, and it answers where cast iron would not, being too heavy and liable to crack; it is also sufficiently soft to allow any name or address to be engraved on without much trouble, and therefore cheaply.

Britannia metal may be regarded as a superior kind of pewter, and, like the latter, its use depends on its cheapness and on the ease with which it is melted, and on its softness, enabling it to be turned in a lathe, and cut of any required shape.

Iron.—Iron is, of all metals, the most useful and really valuable to man—and, by the kind care of the Creator, it

42. What of pewter, its properties and uses?

is one of the most abundant. It is found in every country in soils, in rocks, and in quarries, combined with other substances in the form of various ores, but it is very rarely met with in a metallic state. [In the United States iron mines are very numerous, particularly in Pennsylvania, Ohio, Kentucky, Vermont, New Jersey, Massachusetts, and New York. Pittsburgh is largely devoted to the manufacture of iron, and the extensive increase of mining and manufacturing operations in this country is not yet sufficient to meet the demand, so that large quantities of manufactured iron are still imported from Great Britain. The amount of iron annually produced in the United States is 300,000 tons, and yet much more is consumed in this country. Our railroads have used 40,000 tons annually, and 50,000 tons are consumed annually in our own manufacture of nails. The annual value of the iron manufactories of the United States is computed at 50 millions of dollars. The most useful of all the ores of iron is that which is termed clay iron ore, because the iron is united with a large quantity of clay. It is from this ore that the iron used in England is obtained; the first process is to roast or heat the ore for some time, so as to drive away any small portions of sulphur which it may contain; it is then mixed with coke and lime, and the whole thrown into immense furnaces, lighted, and kept at an intense heat by blasts of hot air, forced in by steam-engines; the use of the coke is to supply the heat as it burns, while the lime unites with the clay and earthy matters of the ore; and forms an easily melted mass, which is allowed to escape. The melted iron, being the heaviest substance in the furnace, sinks to the bottom, and every twelve hours is allowed to flow out into channels made in sand. The shape of these channels into which the melted iron runs and cools, has caused the workmen to call the iron pig-iron, and it is always known by this name in commerce. Thus obtained, iron is usually very hard and brittle, and is

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43. Why is iron the most abundant metal?
44. Where is it abundant in the United States?
45. How is it obtained from its ores?

melted without much difficulty and cast into various articles; hence it is frequently termed cast-iron.

In order to form iron fit for the blacksmith's use, or forged iron, as it is termed, the cast iron is melted by an intense heat, and exposed to the air for about two hours; it is then cooled suddenly, and again heated in another furnace until it melts; after a short time it begins to thicken, when it is taken out and beaten by heavy hammers, and rolled under immense pressure whilst still hot—by these operations its nature is much changed—it is no longer brittle, but excessively tough and strong—infusible, and, to a certain degree malleable.

Forged or malleable iron, as thus produced, is usually of a grayish white colour, with a slight shade of blue. It is ductile to a very great degree, for it can be drawn into wire less than a quarter of the size of human hair. It also possesses a very considerable power of malleability, for it can be rolled or hammered into sheets, although not into such excessively thin leaves as gold, silver, or copper, can; but the quality that renders iron of such extreme use to man is its immense strength and toughness, or tenacity—in which quality it exceeds that of all other metals: if a chain or wire be required of great strength, iron is taken to form it; if a tank or vessel to hold large quantities of water is made, it is of iron, because it is the strongest as well as the cheapest material that could be employed. Forged iron, although it can scarcely be melted by the most extreme heat, is readily worked into any shape—for when heated to bright redness, or to whiteness, it becomes sufficiently soft to be moulded by the heavy blows of a hammer, or to be cut or punched with holes by the tools of the blacksmith. Iron possesses an invaluable property that is not found in any other common metal; it is that of welding: when two pieces of iron are heated to whiteness and hammered together, they unite firmly, and are as strong at the place where they are joined as else-

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46. How is iron forged and made, and how changed?
47. What of its ductility and malleability?
48. In what property does it excel the other metals?

where. Without this property iron chains could not be made without soldering, and then the strength would be so much lessened that they would not be fit for the uses to which they are now applied, as for cables, harness for wagon horses, &c. One would be apt to imagine that so strong a metal would necessarily be very heavy; but as, if it had been of very great weight, iron would not have been so useful to man, it has been benevolently ordered by a kind and thoughtful Providence that it should be very light compared with the other metals; it is much lighter than silver, copper, or lead.

[Ships of the largest class now traverse the ocean by wind and steam, which are built entirely of iron, and such is the control over this metal acquired by the improvements of the blast furnace, slitting, and rolling mills, and other modern inventions in mechanical skill, that iron can now be moulded in any conceivable shape with as much ease as though it were paper or cloth.]

Not only is iron valuable to us as a tough and somewhat malleable metal, but we possess the power of rendering it very hard, and of removing this ductility: this is done by cooling iron suddenly, by plunging it into water. The blacksmith, after making a hoe or a ploughshare, renders it still more valuable by hardening it as much as possible, as, after it is once formed, it is not required to be malleable; he does this by plunging it whilst hot into water; and if at any time it should require altering in shape, it has only to be heated in the forge, and it again becomes malleable.

Besides all these properties rendering it so valuable to man, iron possesses another not less important than any of those before mentioned. If bars of the best iron are taken and surrounded with powdered charcoal, and then heated to whiteness for some days, it is much changed in its appearance—it has become excessively hard, and much more elastic than before, and is called Steel. It is of this

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49. What of welding and the weight of iron?
50. How is it hardened?
51. How is steel made, and to what uses is it applied?

material that penknives, scissors, razors, table-knives, and all cutting instruments are formed; the steel springs of bells and watch-springs are also made of this substance. It may strike us with surprise that so brittle a body as a penknife, and so elastic a one as a watch-spring, can be formed of the same material; but steel can be altered in the same manner as iron is: by being suddenly cooled, it becomes very hard and brittle, but if it is cooled very slowly it is elastic and not so hard: by attention and experience the workman is enabled to give the exact degree of hardness required to all steel instruments. Both iron and steel are capable of being highly polished, and when exposed to dry air they undergo no change, but if there is much damp they become rusty. The rust of iron, however unlike the rust of copper, is not unwholesome, but, on the contrary, it is, as well as many other preparations of the metal, used as a strengthening medicine.

Iron is also used in dying black, and in making ink. (See INK and NUTGALLS.)

The needle of the mariner's compass, which always points to the poles, and so enables him to steer his ship across the pathless ocean, is formed of iron or steel rendered magnetic, either by rubbing with a loadstone, or other means: not any of our common metals could be used for the same purpose.

[ZINC, is chiefly obtained from Germany and Belgium, and is chiefly useful for combining with copper and other metals, as in the manufacture of brass, bronze, &c. It has been lately introduced for the manufacture of bath tubs, pipes, and various utensils, but is not adapted to culinary purposes, because of the poisonous nature of its salts.

The other metals *enumerated* will be found fully described in the volume of this series entitled, the "Rudiments of Chemistry."]

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52. What difference between cooling it slowly and suddenly.
53. Name other valuable uses of iron and steel.
54. Whence is zinc obtained, and its uses?

MINERALS.

[A FEW only of this class of bodies will be described here, and only those which are familiar to young persons.]

CHALK.—Chalk is a mineral substance, consisting of lime, the acrid and caustic properties of which are destroyed by its being united to carbonic acid gas. This acid gas is given off if the chalk is placed in a stronger acid, such as vinegar, and occasions a foaming or effervescence.

When chalk is heated to redness, this gas is driven off by the heat, and caustic lime remains. It is in this way that lime is formed, by burning the commoner kinds of chalk or limestone in kilns.

Chalk is one of the most common minerals. It forms several ranges of hills in the south of England, which are distinguished by their rounded summits. [It was the hills of chalk, the white cliffs of England, which conferred on it the name of Albion, from *albus*, white. The chalk formation is an important geological feature of that country, and obtains an elevation in many places of nearly 1000 feet above the level of the sea.]

Limestone is an impure kind of chalk. Marble is of the same nature as chalk, only of a harder texture.

As chalk lies near the surface, it is not obtained by mining, but by simply digging pits or quarries.

Chalk is an article of very extensive use; it is of great value to the farmer, from its improving the quality of clayey lands. Its white colour and friable texture render it useful for drawing, or writing on slates, wood, &c.

When chalk is finely powdered and mixed with water, the latter becomes turbid or milky, from the finer particles

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55. Name the composition of chalk.
56. Where is it found abundant?
57. Describe its properties and uses.

being suspended or held up in the water, while the coarser sink to the bottom. If the water is poured off, it carries all the finest powder with it. On being allowed to stand undisturbed for some time, this settles at the bottom; it is collected and sold under the name of whiting, for cleaning metals, &c.; and when mixed with glue and water, it forms whitewash.

Chalk is used occasionally as a medicine, to correct acidity in the stomach; for the same purpose it is placed in calf-pens for the animals to lick.

Clay.—Clay is an earthy substance, which is readily distinguished by its forming a soft, inelastic, ductile mass when moistened. It is opaque, and usually possesses a very peculiar odour (clayey). Clay, when pure, is white, as we find pipe clay and porcelain clay; but in general it is deeply coloured by the mixture of other substances. The greater part of the clay near London is of a bluish tint; other kinds are of reddish brown, brown, &c.

Few mineral substances are of more importance to man than clay; its great use in the arts arises from the valuable property it possesses of becoming extremely hard when exposed to great heat. From its softness and ductility it can be formed into any required shape, which is readily fixed by burning. Before the clay is made into vessels, sand or flint finely powdered is mixed with it (see China), which prevents it becoming cracked in burning. Vessels formed of baked clay are hard, brittle, opaque, and porous, permitting water slowly to pass through them; therefore, before use, they require to be glazed. A description of this process is inserted under the article "China." The coarser kinds of clay are manufactured into bricks and tiles; the clay being shaped in moulds, is dried in the sun, and baked in kilns.

Clay is also used to form the bottoms of ponds and canals to prevent the water draining away; as the soft mass it forms, when moistened, does not permit water to soak through it.

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58. What of clay, its varieties and uses?

All soils, except sandy heaths and deserts, contain a large portion of clay mixed with the sandy and vegetable substances that form the soil. Good loamy soils, when dry, contain at least one-half their weight of clay. [All clays contain alumine as their basis, of which alum is obtained. They are called argillaceous earths, and combine various other substances, such as flint, oxide of iron, &c., the red colour, as of bricks, depending upon the presence of iron in the clay.]

Coal.—Coal is the name used by us to signify a black, brittle, inflammable substance, found sometimes near the surface, but usually at a considerable depth under the earth. The word was originally applied to any substance used for fuel, and in this sense it occurs frequently in the New Testament. The general use of mineral, or sea coal, as it was formerly termed, from being brought to us by sea, did not prevail in London until little more than 200 years ago. From its stony appearance, and being dug out of the ground, coal is usually considered as a mineral substance; but there is no doubt of its being the remains of vegetables. It is not uncommon to find pieces of coal distinctly fibrous like charcoal. In many mines the remains of trees and plants are found only partly converted into coal; even the leaves and fruits are sometimes seen. So perfect are many of these parts, that it has been ascertained that coals are the remains of such plants as fir-trees and ferns, &c., of a kind that we are not now acquainted with. Coal is found in beds or layers, deep under the surface of the ground; each of the layers is usually from three or four, to eight or nine feet in thickness, and they lie one over the other, separated by layers of rock or stone. Sometimes the stone between the layers of coal is ironstone, which is also valuable.

The process of obtaining coal is termed mining, and as the expense is very great, mines are usually worked by a company of persons. When by boring down into the

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59. Of what ingredients is clay composed?
60. Describe coal, its nature, and use.

earth coal is discovered, an immense well, eight or ten feet in diameter, is dug, and if necessary, the sides of it are bricked all round. This well is called a shaft. When it is dug down to a layer or seam of coal, they make large passages about twelve feet broad, and as high as the layer of coal is. There are usually two of these passages made at first, extending in opposite directions; the coal which is dug out of them being drawn to the surface by a large steam-engine placed there. From these two large passages proceed others of a smaller size at right angles; and at last a large number of passages are formed (like streets in a town), and they are separated by immense square pillars of coal left to support the roof. If the mine becomes larger, a second shaft has to be dug, in order that all the foul and explosive air that is frequently given out by the coal, should be carried out by a thorough draught of pure air, which is caused to rush down one shaft, and up the other. The draught is directed by doors being shut across passages, where it is not required.

The dangers of working the mines are many: sometimes the roof falls in, crushing the workmen; sometimes large springs open into the mine, drowning many; and gas escapes from the coal, which takes fire from some light coming in contact with it, killing all in the mine; or a suffocating gas chokes them. The explosions are now much prevented by the use of a lamp enclosed in a case of wire gauze, which prevents the flame passing out so as to set fire to the gas. [This was invented by Sir Humphry Davy, and is called a safety lamp.]

Coal is a black, brittle substance, inflammable at a red heat, when it burns with much flame, from the gas that is formed. The use of coal for fuel is very great, not only for our houses, but for manufactures; without coal no iron could be obtained, nor glass, nor porcelain, nor, in fact, any of the numerous things formed by the aid of furnaces. Besides these purposes to which coal is applied, when heated in iron vessels, it gives out gas, which is carried

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61. What of mining for coal, and its dangers?
62. What is the safety-lamp, and its use?

by iron pipes, to the houses in towns, and is of great use in lighting the streets at night. After the coal has given out its gas, it is still very valuable, as it burns with a clear fire without flame or smoke; in this state it is called coke. From the gas factory, tar and several other substances are produced.

[The coal mines of the United States are numerous, and in quality as well as extent unsurpassed in the world. The anthracite coal found in so rich abundance in Pennsylvania, possesses peculiarly advantageous properties for manufacturing purposes, by the absence of any considerable proportion of sulphur, and other deleterious admixtures, so objectionable in bituminous coal. The expense of working iron with this coal is diminished more than 50 per cent., while there is less waste, and the metal is found to have more malleability and tenacity, and is every way superior. So, also, for all other manufacturing and mechanical purposes this coal is vastly preferable.

Moreover these mines, for the most part, are not subterraneous, the removal of a few inches of the soil only being necessary, in many cases, to reach the coal. The iron ore, in exhaustless beds, lies beside the coal, as though infinite wisdom had designed thus to facilitate this important manufacture, so invaluable to man. Who can enumerate, much less estimate, the utility of mineral coal? It supplies fuel for an innumerable population, though every other material for the purpose may be exhausted; it furnishes gas to light up the houses and streets of our cities; it turns the wheels of our million of factories, devoted to every species of manufacture and machinery; it impels the locomotive upon its track, with its lengthened train and ponderous load, almost annihilating time and space upon the land; and it covers the ocean with swift-winged steam ships, which defy the winds, and tides, and waves, thus bringing into frequent and almost daily intercourse the inhabitants of the most distant countries, and exchanging the

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63. What of anthracite coal in America?
64. For what purposes is coal valuable?

products of every clime. And yet there are countless millions of acres in our country, beneath which lie exhaustless beds of the richest coal, amply sufficient to supply the world for ages. And this in close proximity with mountains of iron ore, which yield abundantly to the miner's toil, and, if improved will be far more valuable than the mines of gold which are wrought in Mexico or Peru. A single bed of anthracite coal in Pennsylvania is ascertained to be 60 miles long, two miles wide, and 100 feet deep! While in the western counties of the same state the bituminous coal is even more abundant, covering more than 70,000 square miles. So also in Maryland, a single field covers 400 square miles; in Ohio more than 12,000 square miles of coal are found, while in Virginia there are immense beds, more than 60 feet deep, and of unknown extent. Large amounts of coal are also found in the southern, western, and some of the northern states. The supply, therefore, furnished all over the United States, must ultimately be a source of immense wealth to our growing country, and be equal to any demand.]

Emery Powder.—Emery is a very hard opaque grey mineral, commonly found in large shapeless masses at the foot of several mountains in the islands of the Grecian Archipelago. Small quantities are also found in our own country in iron mines, &c.

Emery is a substance of extreme hardness; it is in consequence of its possessing this property that it is so very useful in the arts as a polishing material. To fit it for this purpose, it is powdered in large iron mortars, or steel mills; the finer parts are then separated by mixing the powder with water, and allowing the coarser particles to subside, when the water containing the finer powder is poured off, and after long standing the latter sinks to the bottom. By this operation emery is reduced to a very fine powder; so fine that it will polish metals, &c. without scratching them. Emery powder thus formed is used in various arts. By lapidaries, for grinding and polishing precious stones; by opticians, for polishing glasses; by

cutlers, in finishing their instruments; and also by masons in polishing marble.

Emery is also used in making emery paper. A strong cement is spread upon strong coarse paper, and powdered emery of the requisite degree of fineness sprinkled on it. When dry, this paper is much used in cleaning iron instruments of various kinds. [Emery cloth is now preferred, calico being substituted for paper, and is very useful in the arts.]

FLINT.—Flint or silex is a mineral substance of extreme hardness, but very brittle, and when broken, yielding sharp-edged pieces. When struck against iron or steel, its sharp edge and excessive hardness enable it to cut away a piece of the iron, which being heated to redness by the force of the blow, flies off in a bright spark. Hence, before the introduction of chemical matches, a flint and steel, with some easily inflamed tinder and a sulphur match, were the usual means employed in obtaining an artificial light in this country. Flints are usually of a blackish brown colour, and, when thin, are semi-transparent. They are found in immense numbers amongst the beds of chalk in this and all other countries. When heated to redness, flints lose their colour, becoming grayish white, and perfectly opaque. In this state, they are extensively employed in the manufacture of all kinds of pottery ware. (See China.)

Flints are used in countries where they are large and abundant, for building houses, &c.; for which purpose they are well adapted, as the rough surface gives a firm hold to the mortar, and their indestructible nature resists every change of weather. They are also used for road making, but for this purpose they are not well fitted; as, from their extreme brittleness, they are rapidly ground to dust; at the same time, their hardness wears away with great quickness the shoes of the horses, and even the iron tire of the wheels.

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65. What of emery, and its uses?
66. Describe flint and its properties.

They are also employed in gun-locks for lighting the powder in the pan. For this purpose they are cut into a peculiar shape by the dexterous blows of hammers and the use of a chisel, which is fixed, the flint being struck on the edge. So expert do the workmen become by practice, that one man will in three days make a thousand gun flints.

SALT.—The valuable substance known by the name of salt is found in the greatest abundance in nature, and in situations where both man and animals can easily obtain it. Thus the waters of the ocean contain a very large quantity, and in order to produce it from them, nothing more is required than to allow the waters to evaporate, when the salt remains behind. In this manner an immense quantity is annually procured in England and in other countries.

Formerly the water was allowed to evaporate in the open air, aided by the heat of the sun; but the plan now pursued is to boil away the water in metal pans. In the interior of different countries a great number of salt springs and lakes arise, from the water of which salt is obtained in a similar manner.

Large solid beds or layers of this substance, several yards in depth, are found in many places under the surface of the earth; when thus found, it is called rock salt.

In England it occurs in the greatest abundance at Northwich, in Cheshire. It is found there in two layers; the one nearest the surface is about thirty to fifty yards under ground, and it is about twenty yards thick. The salt, however, is coloured, like coarse sugar candy, and is rendered impure by being mixed with earthy substances. Below this is a layer of stone, in its turn resting upon a bed of salt forty yards thick, which is generally perfectly transparent and colourless.

From these various sources 500,000 tons of salt are annually obtained for the consumption of England alone.

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67. To what uses are flints applied?
68. What of salt, and whence procured?
69. By what process may it be obtained?
70. Is salt found in a solid state, and where?

[Brine springs, or Salines, as they have been called, are very numerous in the United States, especially in western New York, as on the borders of Onondaga lake, where the brine is of such strength that from some of the wells or springs 30 to 40 gallons will yield a bushel of excellent salt. Nearly four millions of bushels are annually produced at these works. Solar evaporation, the gradual application of artificial heat, and rapid boiling in kettles are all employed in manufacturing salt at the Onondaga springs.]

From whatever source procured, salt, if pure, is a white crystalline solid, of a peculiar taste, readily soluble in water, to which it imparts its peculiar taste, and whose weight it increases. It is one of the most important minerals to man; its use as a wholesome seasoning to food is well known. It has also the valuable property of keeping flesh from putrefaction, and it is therefore employed in preserving meat for sea voyages.

It is used in immense quantities in curing or drying fish, as cod, herrings, &c.

It is extremely beneficial to domestic cattle, and is much liked by them; the fattening effects of the food in the salt marshes of the coast is well known. The wild animals of many parts often perform long migrations in order to obtain this substance.

Salt is used as a manure in some peculiar soils, and also for the glazing of very coarse earthenware; and in all chemical factories it is extensively required.

That a substance so invaluable to man should be so abundant, and so universally distributed, is one of the proofs which so continually present themselves, of the foresight and goodness of the Creator.

SAND.—A hard granular mineral substance, formed of the silex or the same material as flint; which occurs in some places on the surface of the ground, in others under the surface; it is also found forming the beds of many rivers, and the shores of the sea.

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71. Where found in the United States?
72. Name its properties and its uses.

Where the surface of the earth is to a great extent covered with sand, it is called a desert, or downs.

Deserts of sand of an immense extent are extremely common in Africa, Arabia, and Persia. The sands forming them are blown about by the high winds, like the waves of the sea, burying caravans of travellers and camels. Other dangers assail those who venture across these deserts; springs seldom occur, and if the water they carry with them is exhausted, all must perish of thirst.

In England and our own country downs of sand are not uncommon. They are formed by the waves of the sea, driving a quantity of fine sand on the beach; this is carried forward by the wind when it blows inland, and is deposited. Sometimes even a large tract of country is thus converted into downs, and villages and towns have been gradually overwhelmed by mounds of sand. This event occurred some years ago to the town of Findhorn, on the coast of Morayshire, in Scotland, where a fertile and highly productive district of ten square miles in extent has been rendered barren by being gradually covered with drifting sand. The same effect also takes place on the west coast of the Hebrides; the inhabitants, however, partly succeed in preventing it, by setting reeds and grass in the sands; these take root, and thus bind the sands together.

Sand is a material of great value for many purposes in the arts. The whiter kinds are used extensively in making glass (see glass). The coarser kinds are used for making mortar (see mortar); and also in brickmaking; for manuring heavy clay soils, which they render lighter and more pervious to water, and thus allow the roots of plants to penetrate more freely.

Sand is also useful in cleaning and scouring, by its gritty nature helping to remove dirt; and some kinds are used to make the moulds in which melted metal is cast for cannon, and in which iron, brass, and other metal articles are cast.

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73. Define sand, and its most abundant sources.
74. What is said of deserts, and downs of sand?
75. Name the uses of sand in the arts, &c.

SLATE.—Slate is a kind of stone not crystallized, but foliated, or composed of flat layers, which may be easily separated from one another. In colour it varies very much; the most common is bluish black; other kinds are green, brown, bluish, &c. Slate is not a very heavy stone, it being about three times the weight of water.

The slate used in England is dug out of the open quarries of Yorkshire, Westmoreland, Wales, and Derbyshire, &c. It is obtained in large flat pieces by means of wedges; and these are again divided into thinner portions, by the use of smaller wedges. Some of the larger and thicker pieces are sawn, like stone, into the required shape.

Slate, from its lightness and its being impervious to water, is much used for covering roofs of houses, &c. When applied in this way, it is split into layers of the required thickness; these are pierced with holes and fastened with pegs to the laths of the roof, the top ones being made to overlap the lower (like the scales of a fish) so as to keep out the rain. For this purpose pieces are taken that are very free from pores, smooth, and that split readily. It is ascertained to be free from pores by placing a portion in water, weighing it both before and after it is put in; if it is found to have increased much in weight by absorbing water, it is not used for roofing, as such slate not only allows the rain water to soak through and rot the wood work underneath, but it becomes covered with mosses, which also retain the moisture.

Writing slates are made from the smoothest pieces; these are split, when fresh from the quarry, as they divide more readily at that time. They are then ground smooth with fine sand, and in that state used for writing on with slate pencil, which is nothing more than the softest and most splintery kind of slate cut up into the required size.

Slate is now getting into use for many purposes to which it was not formerly applied; thus it is sometimes used for grave-stones, chimney-pieces, for paving, and also

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76. What of slate, and its varieties?
77. Whence obtained, and how prepared?
78. To what uses is slate chiefly applied?
79. What of slates and pencils?

for making water cisterns: for which purpose the less absorbent slabs are well adapted, as they neither absorb the water, or even grease, should it come in contact with them. For this reason slate cannot be painted, as the paint readily peals off when dry. Inkstands, slabs, and various small articles, are now frequently made from slate.

MANUFACTURED ARTICLES.

ALUM.—This substance is found, occurring naturally, near volcanoes. It is also prepared by a chemical process, from alumine, a kind of bluish-gray slaty mineral, found at Paisley, and at Whitley, in Yorkshire, at which places are the chief alum factories of England.

[It is also abundant in many parts of America, especially in the state of New York.]

Alum is a saline substance, soluble in water; and on the water being allowed to evaporate, it is left in the form of crystals, in which state it is usually sold in the shops.

It contains so much water—nearly half its weight—that when heated it melts, and the water gradually boils away, leaving a dry white powder, which is sold by the chemists as burnt alum. The taste of alum is astringent, but at the same time sweetish. It is transparent and colourless. The uses of alum in the arts are very numerous, as, in the manufacture of many colours for painters; in dyeing, and in printing calico. In preparing some kinds of leather it is much employed (see Leather). Candle makers use it to harden and whiten tallow; and bakers to whiten the

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80. Name its other properties and uses.
81. Where is alum found, native and otherwise?
82. What is alum, as found in the shops?
83. Name its properties and uses.

bread; the latter should rather be termed an abuse than a use, as it is injurious to the health. Alum is a valuable medicine, acting as a powerful astringent; hence it is used, when dissolved, as a gargle in relaxed sore throats; and it is also employed to stop bleeding from leech-bites.

China, Earthenware, and Red Ware.—These three substances, which are sometimes classed together under the name of pottery, are so much alike in their composition and manufacture that it would occasion great repetition to describe them separately. It will be better, therefore, to treat of their manufacture together, and state the points in which they differ afterwards.

The ingredients used in making pottery are clay and flint. The quality of the clay is of great importance; that used in England is principally brought from Dorsetshire and Devonshire (although, for making china, a very superior kind is obtained from Cornwall). The clay is mixed, usually, by the aid of machinery, with very pure water, until it is of the thickness of cream. This mixture is strained through lawn sieves, in order perfectly to separate from it any grit. The flints used are burnt in a kiln, and whilst red hot, thrown into cold water; this renders them brittle, and, consequently, more easily ground. When they are reduced to powder, which is done in a mill, they are mixed with a large quantity of water, and much stirred, or agitated; this causes the finer parts to mix with the water, while the coarser powder settles at the bottom. The water and the fine powder are then drawn off, and allowed to stand for some time, when the latter settles at the bottom, and the greater part of the water is poured away.

The potter then mixes together, in a large vat, the requisite proportions of the clay and water, and the flint and water. When the whole is thoroughly mixed, it is passed several times through a fine silk sieve, not only to ensure its freedom from grit, but also its perfect uniformity. This mixture of clay, flint, and water (which is called *slip*)

84. What varieties of pottery are spoken of?
85. Of what ingredients, and how mixed?

is then pumped into a boiler, or kiln, and the water evaporated, or boiled away, until the mass is left of a proper consistence for working. As soon as removed from the kiln, it is beaten with wooden mallets, in order to expel any air it may contain, and is then fit for being formed into the different vessels for which it is designed.

The clay thus prepared is formed into the shape of the vessels required, in three different ways. The first method is called by the workmen *throwing*, and is performed by means of the potter's wheel. This consists of a small round table, at which the potter sits, and which is turned round and round by an assistant working a handle. On this table, or wheel, articles of a circular or round form are made. A lump of prepared clay, and flint, of the proper size, is thrown upon the centre of this table, which is then put in motion by a woman, and as it turns round with the clay, the thrower, or potter, fashions or moulds the latter into the desired shape, forming a hollow in it, by pressing with his thumbs in the middle, drawing it out at the edges, and moulding it until it is finished. The table, or wheel, is then stopped, and the article is separated from it by drawing a wire underneath. It is then carried to a ware-room to harden.

The articles made by the potter's wheel are rough, and not finished in shape. A teacup, for instance, has not the foot nicely formed; it is not hollow underneath, or round at the edge. In order to give the articles the exact shape required, they are turned in a lathe, like that used by wood turners, and cut and smoothed with iron instruments. Such vessels as require handles and spouts, are taken, after being turned, to the *handler*, who forms the handles, &c. in moulds, and fixes them on with soft clay, or *slip*. There are, however, many oval or angular articles, such as cream jugs, &c., that cannot be formed by the potter's wheel; these are made by pressing the soft clay into moulds of the required shape, made of plaster of Paris.

Plates, saucers, and other flat articles, are formed by pressing the soft clay on moulds, which are the shape

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86. What of throwing, and how performed?

of the inside of the saucer, &c., and smoothing the outside.

In whatever manner the vessels are formed, they are allowed some time to become dry, when they are carefully placed in large clay boxes, called seggars, and baked in an oven, or kiln. When first put in, the fire is moderate, but it is afterwards increased, until the whole is brought to a white heat. Baking the article occupies about forty-eight hours, and the oven is allowed gradually to cool for twenty-four hours before it is opened.

The pottery, after baking, is hard and firm, but at the same time porous, and not waterproof. In this state it is called biscuit, or biscuit porcelain.

The next operation is to form on it the patterns which are to ornament it. This is done by first printing the patterns in the desired colours, on tissue paper. The pattern is then cut out from the sheet of paper, and pressed upon the vessel, which, being porous, absorbs the colour; the tissue paper is then washed off, and the colour dried in by heat.

To render these porous vessels fit for holding liquids, they must be glazed: this is done by dipping them in a liquid, which is generally formed of white lead, ground flint, and water. They are then heated in the glazing oven to a sufficient degree to melt the glaze, which runs over and covers the surface, rendering it impervious to water.

The difference between china, earthenware, and red ware, is simply owing to the different kinds of clay and other materials used. For china, a very pure white clay is necessary: this is obtained from Cornwall. In the manufacturing, the china is so highly heated as nearly to melt; thus it becomes semi-transparent. For earthenware, a less pure clay is obtained from Dorset; and for the coarse red ware, a large portion of common red clay is used. [In various parts of America the porcelain earths are found, but the best is in Delaware near Wilmington.

87. How are the articles otherwise formed?
88. What of baking, and how ornamented?
89. How is the glazing done, and its use?

The only porcelain manufactory in America is at Philadelphia.]

CHLORIDE OF LIME.—This substance is formed by placing fresh burnt lime in chambers or closed vessels, where it is exposed to a gas called chlorine; which it absorbs in great quantity, and acquires its peculiar odour. The gas chlorine is distinguished by several remarkable properties; it possesses a most peculiar odour, it destroys all vegetable colours placed in it—hence its great use in bleaching; it also removes infection, or any unpleasant smell arising from decaying substances. It is, if breathed in small quantities, extremely wholesome; but if much of it is mixed with the air, it is irritating to a very great degree. The use of chloride of lime depends on the fact that if exposed to the air, it gives out its chlorine: and in such a gradual manner, that the unpleasant effects of the gas are not produced, whilst enough is set free to destroy bad smells, or prevent infection. If it is required to purify a room more rapidly, some acid, such as oil of vitriol and water, may be added, when the gas is given out much more rapidly.

It is recommended that all school-rooms in close and crowded districts should be fumigated with this powerfully disinfecting gas once a week at least. If after school-hours a small quantity, such as an ounce or two, of chloride of lime be placed in a saucer, and a small quantity of oil of vitriol, with three times its bulk of water, be added to it, chlorine is given out; if then the doors, &c. be closed, the room will be completely purified by the morning. If not done in ordinary periods, it is the bounden duty of all persons in authority over schools to see that during the prevalence of infectious disorders, the school-room be not the means of conveying death into many families. This may be readily and effectually accomplished by fumigating with the gas as described. Immense quantities of

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90. What of the varieties of porcelain, &c?
91. What of chloride of lime, and its properties?

chloride of lime are used in bleaching calicoes, linen, &c. &c.

GLASS.—*White Glass, and Green Bottle Glass.*—Glass is an artificial mineral substance, made by melting together sand or flint, and an alkali, either potash or soda. The invention has been known to man many hundred years, perhaps, before the Christian era. Neither the date nor the mode of its discovery are certain, though it is sometimes stated that it was found out by accident; and that some sailors making a large fire on the sea beach, the potash contained in the ashes of the wood they used united by the heat with the sand of the beach and melted into glass. This occurrence is supposed to have taken place on the coast of Syria, where it is certain that glass was first manufactured.

In England and America the manufacture of glass is now brought to as great a degree of perfection as in any other countries. The materials used for flint or white glass are sand, potash, the preparations of lead, termed red lead, and litharge; with a small quantity of some other mineral substances. These, after being well purified, are perfectly mixed, and are then melted together; being exposed to an intense heat in large melting pots made of clay, and built into an immense furnace. The sand and potash are the essential articles in the making of the glass: but the lead is added in large quantities, as it is found to make the glass melt much more readily, also to give it greater brilliancy, and to render it less liable to crack. When these ingredients are thoroughly melted and united (which process usually takes two or three days) the mouth of the melting pot is opened, and the liquid glass within is ready to be formed into any shape desired, by the workmen. The mode adopted is, to take on the end of an iron tube some of this substance, which is then in a moist, tenacious and plastic state, and to blow through the tube and roll the soft mass on flat iron plates, pressing it with various shaped

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92. How used for fumigation, and why?
93. How is glass made, and how discovered?

tools. The workman at last fashions it to the shape desired, which it retains when cold. Perhaps no other substance known could be moulded into such a variety of forms; for melted glass seems to exceed all things in its ductility and tenacity. Its consistence is something between that of soft putty and treacle, neither solid nor liquid, but capable of being bent, blown out, pulled, pressed, twisted, or cut, so as to assume at the will of the workman the various forms required. When the glass articles are made, they have to be annealed, that is, cooled slowly in an oven formed for that purpose: if they did not undergo this process, they would crack on the slightest blow, and would not bear warm liquids, &c. The qualities that render glass so valuable when manufactured, are its hardness, and the polish of its surface, which renders it so readily cleaned when soiled—its beautiful transparency, enabling us to perceive its contents when it is used to form vessels for liquids—its being so incorrosive that it is not acted upon by any ordinary substances, not even by the strongest acids, with one exception. Its value, again, as a substance for glazing windows depends on its transparency and its insolubility; so that whilst it admits the light, and even the warmth of the sun, it perfectly excludes the wind and wet, and even to a great extent the cold. It is, in fact, only the circumstance of its being so common, so constantly before our eyes, that renders us usually insensible to its exceeding value and its great beauty.

Although glass readily allows the light to pass through it, yet when it is made into certain shapes it has a great effect upon the light, sometimes bringing it into one point, &c.; such pieces of glass are termed lenses, and are used for making telescopes, microscopes, &c., and singly for spectacles.

The dark green glass, of which wine bottles are made, is merely glass of the coarsest kind; it being made

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94. Describe its manufacture.
95. What are the properties of melted glass?
96. Describe annealing, and the value of glass.
97. What useful instruments are made of it?

of the common dark-coloured sand, and the coarsest alkali.

KEY.—The use of this instrument is so well known as scarcely to need description. Its value depends upon the circumstance of the lock it is made to open being so formed, by a number of thin pieces of metal, termed wards, placed in its interior, that the key to open it must have a part filed away to correspond with each ward, so that it may turn round and push back the catch or bolt. The parts of the key are termed by the maker the bow, the shank, and the bit. Until within about fifty years, keys were made by being hammered out of a bar of hot iron on an anvil; they are now formed by placing a piece of iron of the required shape, previously heated, under a powerful stamp, which forms the bow, the shank, and bit; the key is then filed smooth, the shank bored or turned, and is then sold to the locksmith under the name of a blank. It is from these blanks of various sizes that the locksmith prepares keys, filing the bits so as to suit any lock they are making.

MORTAR.—Mortar is a substance which, from possessing the power of hardening gradually from a soft state, is used for the purpose of cementing together the bricks or stone used in building.

Mortar is formed of lime, fresh burnt and slaked, and sand; water being added in sufficient quantity to make the whole mixture a soft paste, when the materials are well worked up together. The proportions employed are usually one bushel of lime and one bushel and a half of sand; but, for particular purposes, these quantities are varied. As thus formed, the mortar is spread between the bricks, &c. of a building, and, by being exposed to the air, it gradually hardens, from the water evaporating, and also from the lime undergoing a chemical change, which renders it insoluble, by uniting or combining with water;

98. Explain the nature of a key and lock.
99. What improvement in making keys?

therefore, mortar which has hardened or *set*, as it is termed, is not softened when exposed to wet, hence its great use in building.

NEEDLES.—These small, but at the same time exceedingly valuable instruments, are made in immense numbers in England, both for home use and for exportation. The material from which they are made is soft steel wire of the required thickness: this is bought by the needle-maker in large coils, each of which contains enough wire to make many thousand needles; the coil is divided into pieces the length required for two needles, which is usually about three inches; large shears are used capable of cutting a hundred wires at once. Many thousands of these pieces are then taken and made into bundles, being kept together by a ring of steel at each end; they are then placed in a furnace and heated to redness, when they are taken out and laid on a flat iron plate; the worker then with a steel bar rolls the wires (still kept together by the rings at each end).

After this stage of the manufacture, the wires are perfectly straight, of the required length for two needles, blunt at each end, and dull, from having been heated in the furnace. The next step is to grind a point at each end of the wire: this is done very quickly, by the aid of a small grindstone revolving very rapidly. The grinder takes from fifty to a hundred of these wires between the palm and fingers of his hands; and as he presses them against the quick moving stone, he so guides his fingers as to cause all the wires to roll round, and thus be ground to a point. So expert do the grinders become by practice, that they will point a handful of these wires, about a hundred in number, in half a minute, or about ten thousand in an hour. Whilst being ground, each wire of the hundred sends out a stream of sparks, and together they form a bright glare of light. Pointing the wires is the most unhealthy part of the manufacture; for the fine dust

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100. What of mortar, its nature and uses?

is carried into the lungs of the workmen, and destroys them in a few years, not many living beyond the age of forty.

The wires, thus pointed at each end, are taken to the stamping machine; which is nothing more than a heavy hammer of about thirty pounds' weight, moved up and down by a lever worked by the foot. The under surface of this hammer is so formed, that when the workman lets it fall upon the wire midway between the two ends or points, it forms the gutters or little grooves in which the eye is afterwards made; and the anvil on which the wire rests when the hammer strikes it, is likewise so formed that it makes the two grooves on the other side of the wire.

Besides making the grooves, the stamper, or hammer, partly makes the eyes for the two needles. The wires then go to a boy, who takes a number of them in his left hand, spreading them out flat, whilst with his right he works a press moving two hard steel points or piercers; and as he places each wire beneath the points, he works the press, and the points come down and cut out the eyes for the two needles. Each wire now nearly resembles two rough unpolished needles fastened together in a straight line, by their heads; and as it would take much time to divide each wire separately into two needles, a little contrivance is adopted by which many are divided at once. A boy takes two fine wires in his right hand, and, holding them close together, he *spits* or *threads* the double needles upon them, and they are then taken to the filer, who separates each bundle into two halves, each of which consists of a number of rough unpolished needles strung on a fine wire. As it is possible that during the numerous operations the needles may have become bent, they are rolled under a steel bar to straighten them; this process is done by hand. They are then hardened, by being heated in a furnace, and then suddenly plunged into cold water or oil. After hardening, they have again to be heated to temper them, so that they may not be brittle. They are again straightened by being hammered on small bright anvils with tiny hammers by girls; and now they are finished all but the polishing and packing up. The first is accom-

plished by taking about twenty or thirty thousand needles, laying them straight side by side upon a piece of thick canvass; they are then smeared with oil and emery. The canvass is rolled up, and rubbed under a press like a mangle, for many hours; after polishing they are examined, and the broken ones removed. Should drilled-eyed needles be required, they undergo another operation, the object of which is to take off the rough edge of the eye, and to polish the head more completely: but this is only done to the finest kinds; lastly, they are counted in bundles of twenty-five, and enclosed in small papers for sale.

The chief place for the manufacture in England is Redditch, in Worcestershire, where, it is stated, 70,000,000 per week are manufactured.

Nails.—Nails are small instruments (usually made of iron) used for the purpose of fastening together separate pieces of wood, or other substances. Each nail consists of three important parts, the point, the shank or body, and the head. The use of the point is to enable the nail to enter the wood more readily, when struck by the hammer, and also to lesson the probability of its cracking, or splitting the wood. The shank or body of the nail is usually left somewhat rough, so that when driven into the wood it is firmly retained. The head of the nail also offers a greater security against slipping, and it is variously shaped, according to the uses for which the nail is required. Those called tacks, used for nailing down carpets, &c., are furnished with flat round heads, in order that they may, without cutting, hold the carpet securely; whilst the nails used by carpenters to fasten down the flooring of rooms have small heads that can be readily struck so far into the wood as not to project and cause irregularities on the floor. Nails are generally made by hand, by persons who work with a blacksmith's forge, having the usual description of bellows and hammers, of

101. How are needles made?
102. Describe the complicated process.
103. What of nails and their use?

a larger and smaller size, according to the size of nails to be made.

The persons pursuing this employment, whether men or women, are termed nailors. They use iron which has been rolled at the foundry into thin rods. One end of these rods is heated in the forge, and then hammered on an anvil, whilst still soft, to a point; and the length of rod requisite to form a nail is then cut off, when the rod is immediately placed in the fire to be reheated, during which process the head of the nail cut off is formed by hammering the nail into a hole in a steel instrument called a bore, the hole being the shape of the head required. The making of a nail takes a much less time than the description of the operation. One man has been known to make 17,000 in one week; and the usual number of nails made by one workman in a week is 6000.

[In the United States the manufacture of nails has become very extensive. It is computed that no less than 50 millions of nails are made in this country every day, and even this falls far short of the demand, and hence the extensive importation of nails from Great Britain.

The flat nails, called brads, are cut out of sheet iron by the aid of powerful and complicated machinery.]

Knife.—Knives or cutting instruments of some description have been used by man from the earliest ages of the world, both for slaughtering animals and cutting up food, &c. The knives at first made were probably of sharp shells, flints, or other hard stones; metals being then unknown. The knives mentioned in the earlier passages of Scripture were probably of this description. (Exod. vi. 25.)

At the present day knives are almost exclusively made of steel; the maker being termed a cutler. Clasp knives consist of several distinct parts—namely, the blade, the spring, the iron sides, and the scales.

The blade is made out of a rod of steel: one end of

104. How made and by whom?
105. What of knives and their parts?

this being heated to redness, is hammered to the shape required, and then cut off with the part to form the joint while hot. The small recess called the nail hole, for opening the blade, is made by means of a chisel of the shape required, which is struck upon it. The blades are hardened by heating them to redness, and plunging them into cold water, and they are afterwards tempered to prevent their being too brittle. The iron sides and the spring are also forged by the workmen. The scales (as they are termed), whether of iron, ivory, mother-of-pearl, or wood, are then taken, and the whole, having been drilled to correspond in the places where the rivets are to pass through, are at first loosely pinned together with bits of wire; and when each part is exactly fitted by filing, &c., the rivets are tightened by hammering. The sides and back of the handle have now to be scraped and polished; this is done on a wheel, somewhat like a grindstone, covered with leather, on which is placed at first sand, and afterwards oil and rotten stone. The blade is lastly ground and polished, and the knife is then fit for use.

The maker's name is usually punched on when the steel is soft. The use of knives depends entirely on the excessive hardness of the steel with which the blades are formed; this allows a very sharp edge to be given to them, which is preserved for some time.

Pin.—This small instrument, from its extensive use, is an important article of manufacture. It is stated that there are made in England, for home use and exportation, more than 15,000,000 pins daily. [They are also very extensively manufactured in America, and a large establishment for the purpose is conducted in the city of New York.]

The mode of making pins is as follows. A quantity of brass wire, of the requisite size, is first cleaned by soaking it in dilute oil of vitriol (sulphuric acid) and water; it is then straightened and cut into pieces a little longer than

106. How are knives made?
107. Describe the process of pin-making.

the length of six pins; these pieces are pointed at each end by a person who sits in front of two small, but broad steel wheels, the rims of which are notched like a file, one coarsely, the other finer. Several of the pieces of wire are taken in the hand, and their ends being applied to the wheels, which are turned round with great rapidity, are ground to points. They are first commenced on the coarse wheel, then finished on the fine one.

After both ends of the piece have been pointed, one pin's length is cut off from each end. The ends left are then pointed, and two more pins' lengths cut off, and so on, until each length is converted into six pointed pieces. The stems of the pins are then complete, and the next step is to form the head. This is effected by winding some small brass wire in a coil round a piece of steel wire, the same size as that of the pins. (The smaller wire is coiled round the larger one in exactly the same manner as the thread is coiled round the wire used for stiffening caps and bonnets.) The coils of small wire are slipped off the large wire, round which they were made, and the workman takes a dozen, or more, coils, and, with a pair of shears, cuts them up into little short pieces of two turns or coils each, and these form the heads of the pins. These heads are then annealed, by being made hot and thrown into water, and are ready to be fixed on the stems. This is done by the workman taking one of the stems, dipping the point of it into a bowl containing the heads, catching one on it and sliding it towards the other end; he then places it on a piece of steel, called a die, containing a hollow the exact shape of half the head, and presses down on the head, four or five times, another similar piece of steel. This operation fastens the head on the stem and gives it the required figure.

The pins are next cleaned, and tinned, by boiling them with a solution of tin. They are then taken out, dried and polished, by being well shaken in a bag with a quantity of bran, which is removed by shaking them in open trays, when the bran flies off, leaving the pins perfectly dry and clean, and ready to be fixed in the papers in which they

are sold. Even this last simple operation is done by the aid of machinery.

Putty is the cement used by glaziers for fastening the glass in the frames of windows. It is composed of linseed oil and whiting. The latter is well dried, pounded, and sifted, till it becomes a fine powder, perfectly free from grit; it is then gradually added to the linseed oil, which is warm. These ingredients are well stirred with a stick, till thoroughly mixed together, and when sufficiently thick, are worked by the hand on a table, and afterwards beaten with a mallet, so as to become a smooth, soft, tenacious mass.

The use of putty depends on the property it possesses of hardening gradually on exposure to the air; after some time it becomes almost as hard as stone.

It is well adapted to the cementing of window frames, as it not only secures the glass firmly, but perfectly closes the joint, so as to prevent draughts of air entering, or the rain from beating through the window. When used in very exposed situations, a small quantity of white lead is added; this has the effect of rendering the putty more durable.

Scissors.—Scissors are a well-known cutting instrument made of iron or steel. The manufacture of scissors consists, first, in the hammering out of the blades from a bar of heated steel; the bow being roughly made by stretching a small hole made in the steel, by hammering it on to a conical anvil. Another workman then files the blades thus roughly forged into a more perfect shape, and bores the hole for the screw; they are then passed to the grinder, who forms the cutting part to its proper shape. The ground blades are then polished by women, who rub them with oil and emery powder. After this they are put together by a screw, and fitted so as to work smoothly over one another. The screw is then removed, and the two blades being wrapped closely together with fine wire, to

108. What of the nature and use of putty?

prevent their warping, are heated to redness, hardened by sudden cooling, and afterwards tempered. After these operations they again require grinding, so as to bring the edges to a perfect state. Another workman then adjusts the screws, filing the blades so as to make them open and shut easily. The parts which had become black by burning, are polished by very fine emery and oil, and again, for the third time, are ground, and the edges whetted; they are then ready for sale, previously to which the handles are sometimes burnished by rubbing with a hard steel burnisher.

Scissors that have ornamented handles are worked by the file and drill, one pair sometimes occupying a workman many days or even weeks in finishing the design.

The edges of the blades of scissors are not ground sharp like those of a knife, therefore in cutting they bruise or crush much more than that instrument. With thin objects, such as paper, cloth, &c., this is not of importance, but it prevents their being usefully employed in cutting thick substances.

THIMBLE.—This well-known little instrument is worn on the middle finger of the right hand, by persons sewing, for the purpose of enabling them, easily and readily, to push the needle through the cloth, and of preventing its head injuring the finger.

It is made so as to suit the shape of the end of the finger, being conical, with a rounded head.

The difference in the thimbles used by men is, that they are open at the end. Thimbles are usually made of some metal, and are pitted on the outside with small sunken *dots*, so that the needle should not slip.

They are made out of a single piece of flat thin metal, which is cut or punched into a circular shape, about two inches in diameter; this is then, either by a machine or by a punch and hammer, forced into a hollow mould, or into several moulds, each smaller than the last, by which it

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109. Describe the manufacture of scissors?
110. What is the process of finishing?
111. What of making thimbles?

acquires somewhat the shape desired. It is then fixed in a lathe, and turned smooth, inside and out, after which the depressions are indented, or pressed in. Thimbles are frequently made of silver, which is, compared with iron, a soft metal, easily worked, and they are often ornamented on the outside with patterns, or initials, engraved or cut in. [Gold thimbles are now very common.]

WATCH-SPRING.—The force employed to turn the key of a watch, in winding it, coils up very tightly a spiral spring, called the main-spring, which is enclosed in a brass box, and is not seen unless the watch be entirely taken to pieces. The force of this spring uncoiling itself, gradually moves the works of the watch.

Both the main and hair-spring of watches (the latter being a very small spring used to regulate the movements) are made from steel wire. The workman first hammers it out on an anvil, by which means it is flattened; it is then ground smooth on both sides; hardened by being heated, and cooled quickly; coiled up, and made to preserve its shape by being heated or tempered, as it is termed.

This last heating gives it the blue colour it possesses, and also seems to increase its wonderful elasticity, and at the same time to preserve it from rusting so readily as it otherwise would do.

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112. Explain the nature of a watch-spring.
113. What of its manufacture?

OBJECTS

DERIVED FROM

THE VEGETABLE KINGDOM.

CORN.

INTRODUCTION.—The word corn is used as a general name for various kinds of grain—such as the grain of wheat, of barley, of oats, of rye, of maize, which last is chiefly used in America, and is frequently called Indian corn. [This is the only species of grain generally known in the United States by the name of corn, and it is undoubtedly indigenous, for it was unknown in Europe until since the discovery of America. It is not sown like other grain, but is planted like potatoes in the ground, and covered with the hoe.] Though so many different plants come under the name of corn, there are certain characters or marks by which they may be distinguished, and which we will consider before we proceed to the description of each sort in particular.

There are, likewise, certain words used in describing the culture of corn and its preparation for human food, which we will endeavour to define at once, and thus avoid repetition under each head.

The various corn-plants are only grasses of a larger kind. They are all annual, the whole plant, including the root, dying when the seed is perfected.

The stem of all is hollow and is generally called straw, but in some places culm. The inside of this hollow stem

114. What of the varieties of corn?
115. Describe the general structure of corn-plants.

is divided by partitions, which form joints. One use of this structure is evidently to strengthen the stem; from these joints or knots the leaves grow; embracing or forming a sheath to the stem for some distance. The leaves are all long and taper, and the veins run straight and parallel with one another from the base to the termination, instead of branching out, and uniting again so as to form a network, as is the case in most leaves.

The blossoms of corn-plants are collected into a head, or ear, or spike, and are not coloured like the flowers of most plants. Those parts of the flower which, in most other plants, are large and coloured, are in these small and scale-like. When separated from the grain after the corn is ripe, these parts are called the chaff or husk.

The difference between corn-plants and the grasses is merely in size. The seeds of all grasses might be used as food, if they were large enough to make it worth while to collect them for that purpose; no grass-plants, with the exception of one (the common darnel grass), being unwholesome.

The cultivation of the soil is called agriculture, from *ager*, a field, and *cultura*, culture.

The measure generally used to express the size of fields, &c., is called an acre, and a field is said to consist of so many acres.

The first operation necessary in agriculture is that of breaking up the ground by means of a plough; this is called ploughing. The earth, when broken up, generally requires to be mixed with other substances (in order to increase its power of nourishing the seed), varying according to the nature of the soil. These substances (which are sometimes bone, sometimes lime, or fish, or seaweed, &c.) are classed under the word manure; and the process of mixing them with the soil is called manuring the land. When the land is properly prepared, the seed-corn is sown.

This is done in one of two ways, according to circumstances. In one, the sower takes a handful, and scatters

116. What of their blossoms and flowers?
117. How is the soil prepared?

the seed on the surface of the ground, by swinging his arm in a circular direction, while he opens his hand at the same time. This is called *sowing broadcast.* The second method is to make holes in straight rows, into each of which seed is dropped. This is called drilling or dibbling, and is, in most cases, preferable to the first method; but in some soils it cannot be adopted. Each seed produces more than one stalk; the grain is then said to *tiller.*

The growing plants produced in a field, thus prepared and sown, are called the *crop.*

When ripe, the crop is cut down; this is called reaping.

The grain is beaten out from the husk by a process called threshing.

The grain is then separated from the particles of husk with which it is mixed, by means of a current of air strongly forced upon it. The chaff, being light, is blown away: the grain, being heavy, remains; this is called winnowing.

The grain, thus cleaned, is next measured out in bushel measures. The number of bushels is then divided by the number of acres of land on which the corn grew, and the produce is said to be *so many bushels an acre.*

Grain is sometimes used without any other preparation than cleaning it; sometimes reduced to a mealy powder, called flour, according to the purposes for which it is required. The grain is ground in mills to reduce it to flour; and in the same mill, the flour or mealy portion is separated from the outer skin, which is called bran. [The amount of grain of all kinds, produced annually in the United States, exceeds 800 millions of bushels.]

WHEAT.—Wheat is the most esteemed of all kinds of corn, and, where it can be cultivated, and the people are not too poor to use it, is invariably preferred as food. In England, two kinds of wheat are cultivated, and they are called, from the seasons in which they are sown, spring or summer wheat, and winter or Lammas wheat.

Spring wheat is a much more delicate plant than winter

118. What of winnowing, measuring, and grinding?
119. Describe wheat, and its varieties.

wheat. The ear is more slender, and is readily known by being provided with long awns or beards. Its grain is smaller, and it is less productive; therefore it is seldom sown by the farmer, unless the winter crop fails, or the land cannot be got ready in time to sow the winter kind.

It is not uncommon, in the case of a failure in a crop of winter wheat, to sow the spring wheat in April or May; as it may be depended on for producing a fair return in the following autumn. Sometimes, patches of spring wheat are sown amongst the winter kind, where the latter has partially failed. If this is done about the commencement of April, both kinds will ripen at the same time.

Winter wheat is a more vigorous plant, and it is destitute of the long awn or beard. Some varieties of winter wheat are redder than others; hence we hear of red and white wheat.

Wheat is most commonly sown broadcast, though, of late years, the practice of dibbling has been introduced to a considerable extent.

Wheat plants tiller very freely; the usual number of stalks arising from one grain is five, but sometimes many more.

The produce of wheat at the present time in England, is about 24 to 28 bushels an acre. In those counties where manure is cheap and agriculture carried to a high state of perfection, a much larger quantity is produced. In Middlesex, for example, upwards of 40 bushels are not unfrequent from a single acre.

From every 12 bushels of wheat one load of straw is usually obtained, which is made up into 36 parts, called trusses. The weight of a bushel of wheat is usually 60 pounds. This, on being ground, yields

Bread-flour . .	47	pounds.
Pollard . . .	8	"
Bran	3	"
Loss in grinding	2	"
Total - -	60	

120. What is said of sowing, and tillering?
121. What is its produce per acre?

[More than 100 millions of bushels of wheat are annually produced in the United States. The produce of wheat in this country is greater than in Europe, many fields yielding more than 50 bushels to an acre.]

BARLEY.—Barley is more cultivated in England than any corn, except wheat; for, although bread is not now made of it, as formerly, it is used very extensively for the making of fermented and spirituous liquors.

Barley is a much more hardy grain than wheat. It comes more quickly to maturity, and in short, dry summers ripens perfectly when the other grains do not. In Spain and the Eastern countries, two harvests of barley are collected each year. This fact explains a passage in Exodus (ix. 31), where the plague of hail is mentioned—"The flax and the barley were smitten: for the barley was in the ear." . . . "But the wheat and the rye were not smitten; for they were not come up." This event happened in March; the first crop of barley was, therefore, nearly ripe, being sown the previous autumn; but the wheat and the rye were not sufficiently advanced in growth to be injured by the hail.

In this country, barley is usually sown in the spring, and reaped the following autumn. It thrives best in dry seasons. If there be much wet, it becomes sickly; and in very wet seasons, the grains contained in the ear will sprout while the plant is yet in the ground; so that each ear resembles in appearance a tuft of grass.

Clover is often sown with barley; the two crops growing at the same time.

The quantity of barley produced on an acre of land is from 35 to 50 bushels.

The shape of a grain of barley is well known; and from its tolerably uniform length, it has given name to one of our divisions of the inch—namely, the third; it being reckoned that three barleycorns, placed end to end, make an inch.

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122. For what purpose is barley chiefly used?
123. What Biblical criticism is made here?

Each grain of barley ends in a long awn or beard, which is broken off in threshing. The uses to which barley is applied in this country, are chiefly for the formation of beer and spirit. Some portion, however, is formed into *pearl barley*, by grinding off the outer husk in mills adapted to that purpose.

Barley is also used as food for poultry, and, when ground into meal, for fattening pigs.

At times, when wheat is dear, the labouring classes in the country mix barley flour with their wheat flour to make a cheaper kind of bread; but this food is by no means a favourite with them; as it is coarse, dry, and apt to become sour.

The large quantity of 30,000,000 bushels of barley is yearly consumed in Great Britain, in brewing beer, for which it is prepared by a process called malting, or converting it into malt. This is performed by first steeping the barley in water until it has become soft and swollen. It is then taken out to drain, and allowed to lie in heaps for forty hours; during which time each grain begins to grow, as it would if planted in the moist earth. To check the growth, the barley is then turned and spread out for some days; then heaped together again, and afterwards dried, by being spread out, on a wire or hair cloth, over a kiln; and as it is more or less dried, the colour is dark or light brown, and the malt is used for brewing porter or pale ale.

In malting, barley undergoes the change which all seeds do in beginning to grow. The starch of the seed is converted into sugar; hence the taste of malt is sweet, and the liquor which is afterwards made into beer, and has a bitter taste in consequence of the hops having been added to it, is, in the first instance, when the malt only has been boiled in water, extremely sweet, and in that state is called *sweet* wort. [In America, barley is not extensively cultivated, only three millions of bushels having been raised

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124. What of barleycorns, and pearl barley?
125. Name the uses of barley.
126. Describe the process of malting.

during the last year. The beer and liquor manufacture in this country is on the decline so rapidly, that this may account for the neglect of it by agriculturists.]

Oats.—This grain is much more grown in northern than in southern countries; the oats of the south of England being very inferior to those of Scotland. In appearance, this corn differs much from wheat and barley; the grains are not arranged in a close ear, but form a loose cluster around the stem.

This corn possesses the very great advantage of growing in places too cold and exposed for wheat or barley; in dry and hot seasons, it does not flourish, as the grain becomes husky, and contains little nourishment.

Oats are sown by broadcast, in March or April; about 50 or 60 bushels are the usual produce of an acre.

There are several kinds of oats—some are dark in colour, others light; some have an awn or beard, while others are destitute of such an appendage.

Oats are by no means so nutritious a corn as wheat, or even barley; formerly they were used in the preparation of intoxicating drinks. In the southern parts of Britain, oats are chiefly used as food for horses, and in fattening poultry. Coarsely ground, they are called groats, (a contraction probably of ground oats,) and are much used for making gruel. In Scotland, oats are largely used as human food, both in the form of porridge and made into oaten cakes. These are much eaten in Lancashire also. Although not so nutritious as wheat, oats are an extremely wholesome article of food. [They are never thus used in America except for horses. 150 millions of bushels of oats are annually grown in the United States.]

Rice.—Unlike most corn plants, the native country of rice may be fixed with certainty; it is, undoubtedly, a production of the warmer regions of Asia, in some parts of which it is now found growing wild, and the seed is collected for use. From hence it has been carried by man

127. How do oats differ from wheat and barley?
128. Name the various uses of oats.

over the greater part of Asia, part of Europe, and the continent of America, where it is now cultivated in immense quantities; it was introduced there about 150 years since. In appearance, the stalk and plant of rice may be said to resemble wheat, but the grain is bearded, and not arranged in a close ear. In fertility and abundance of produce, it much exceeds our other grains. In India they raise two crops a year of 30 to 60 bushels each, the ordinary produce of an acre. The great peculiarity in the culture of rice is the large quantity of water it requires. In America, for instance, it is sown in the spring, in rows or trenches about 18 inches apart, and the ground is then flooded for some days; again, when the plant is but a few inches high, the water is allowed to flow over the land and remain for a fortnight; and a third time, shortly before the grain ripens, the fields are again flooded, and remain so until the harvest. From the swampy condition in which the soil is kept, the cultivation of rice is a most unhealthy occupation, and, in America, it is left almost entirely to the care of the slaves, their masters frequently leaving the province during the time. Rice is grown in much the same manner in Italy; and also to an immense extent in the island of Ceylon, China, Africa and India. In all these countries, the best rice fields are the low open grounds through which large rivers pass; in other situations, the waters of the small streams are caused to flow into artificial reservoirs, which are used for watering the grounds. On the grain becoming ripe, the water is drained off, and the corn reaped with a sickle, the labourer being frequently knee-deep in the soft mud in which it grows.

No grain supports the life of so large a number of persons as rice. The inhabitants of China, India, Africa, and a large portion of America, live chiefly upon it. In the south of India it forms, with a few spices called curry, the whole food of an immense number of the inhabitants, and even the resident Europeans eat it with every meal. Rice

129. What of rice, and where cultivated?
130. What is peculiar in its culture?
131. By what class of labourers in America?
132. Name the important uses of rice.

consists almost entirely of starch; hence it cannot with advantage be baked into bread, as the dough is not tough enough to rise. It is, however, light, wholesome, and easily digested. Rice is brought into England in two forms: in the brownish husk, in which state it is called Paddy or Paddee, and with the husk ground off; formerly, the separating the husk was chiefly performed in India, by beating the rice in large earthen or stone mortars: it is now done by machinery taken from England. But, at the present time, very large quantities of unhusked rice or paddee are brought to England; it is found that, from being protected by the husk, the grain is less injured in the passage; and it is more perfectly cleared by the superior machines of that country.

Although rice is not spoken of by name in the Holy Scriptures, it must have been known to the Sacred Historians, and it is most probable that its cultivation is alluded to in Eccl. xi. 1, and Isa. xxxii. 20

SPICES.

The spices are vegetable substances which, from their aromatic, pungent, stimulating qualities, and, in most cases, agreeable taste and odour, are used for flavouring food, and also to assist in preserving it. Taken in small quantities they are not unwholesome, as they assist digestion; in large quantities they are extremely hurtful.

The spices are all foreign productions, procured from tropical climates, chiefly the East and West Indies: not any of the plants that produce them will bear the cold of our climate.

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133. What proof is cited of its antiquity?
134. Of what use are the spices, and whence obtained?

ALLSPICE.—This spice is also named Pimento, and sometimes Jamaica Pepper, from the island whence it is chiefly obtained; it is the berry of a tree somewhat resembling the myrtle in appearance. It grows to the height of 30 feet, the trunk being smooth, and much branched towards the top; the branches are thickly covered with a large number of shining evergreen leaves, which resemble, in size and appearance, those of the sweet bay. In July and August the trees are covered with a great number of small white flowers, contrasting beautifully with the dark green leaves, whilst the whole tree sends forth a rich, fragrant perfume. The allspice tree is chiefly grown in the island of Jamaica; it is there cultivated largely for the sake of its fruit, which is the berry we use as spice. These are plucked by hand before they are ripe, and dried in the sun until the seeds rattle inside when shaken. During the drying, the berries change in colour from green to a reddish brown. If they are allowed to become ripe on the tree, they turn purple, and when dried are found to have lost their aromatic odour and flavour, and are useless as spices. The name of allspice is given to them, because their taste and smell resemble that of a mixture of cinnamon, cloves, and nutmegs.

CINNAMON.—This spice is the inner bark of a tree closely resembling the laurel, or sweet bay, a native originally of Ceylon, but which is now grown in the other parts of the East Indies, and also in Jamaica and other islands of the West Indies. The trees are usually left to grow unmolested until they are nine years old, at which time the young shoots, or branches, that are about three years old, are lopped off. The bark is then slit up on one side and removed from the branch, tied up in bundles until the next day, when it is loosened, and the skin or outer bark scraped off. It is then dried or rolled up into

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135. Where is allspice chiefly cultivated?
136. Describe its nature and peculiarities.
137. Whence is cinnamon procured?
148. Describe the process of gathering it.

quills or pipes, about three feet long, which have a slit down one side, where the bark was cut. The smallest quills are rolled up inside the largest; the whole are then tied up in bundles of 80 or 90 lbs. weight, and wrapped up in cloths, when they are ready for exportation.

Cloves.—Cloves are the unopened flowers of a small evergreen tree that resembles in appearance the laurel or the bay; it is a native of the Molucca, or Spice Islands, but has been carried to all the warmer parts of the world, and is now largely cultivated in the tropical regions of America. The flowers are small in size, and grow in large numbers in clusters at the very ends of the branches. The cloves we use are the flowers gathered before they have opened, and whilst they are still green. After being gathered, they are smoked by a wood fire, and then dried in the sun. Each clove consists of two parts, a round head, which is the four petals or leaves of the flower rolled up, enclosing a number of small stalks or filaments. The other part of the clove is terminated with four points, and is, in fact, the flower-cup, and the unripe seed-vessel. All these parts may be distinctly shown if a few cloves are soaked for a short time in hot water, when the leaves of the flowers soften, and readily unroll. The smell of cloves is very strong and aromatic, but not unpleasant; their taste, when unmixed with other substances, is pungent, acrid, and lasting. Both the taste and smell of cloves depend on the quantity of oil they contain: this is so great, that it may be pressed out with the finger. Sometimes the oil is separated from the cloves before they are sold, and the odour and taste in consequence much weakened by such unfair proceeding.

Ginger.—This spice is the produce of a plant growing in both the East and West Indies. In its appearance it somewhat resembles a reed, or sedge, but the stems arise

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139. What is the nature of cloves?
140. Upon what do their properties depend?
141. What is ginger, and how obtained?

from a root of exactly the same kind as the root of the sweet flag, or iris, that is so commonly grown in our gardens.* Like the root of this flower, that of the ginger-plant spreads and increases in size every year. From the upper surface of this root arises, in the spring, a green reed-like stalk, about two feet and a half high, which bears narrow lance-shaped leaves. The flowers of the plant, which are white and lilac, grow on a separate stem. The ginger we employ as a spice is the root, to obtain which the plant is cultivated in much the same manner as potatoes are, and when the stalks have withered, the roots are dug up. The best and soundest of them are selected, scraped quite clean, and carefully dried in the sun, when they are ready for exportation and use. The inferior roots are scalded in boiling water instead of being scraped; and these when dried form what is called black ginger, a very inferior kind. The colour of black ginger, as it is termed, is yellowish gray on the outside, and orange brown within; in shape it is thick and knotty. The best, or white ginger, being scraped in preparing it, is less in size, not being so thick or knotty; its colour is a light yellow, and its taste is much more pungent and aromatic than that of the black kind.

Nutmegs and Mace.—These two spices are the produce of one tree, which is a native of the East Indies. The tree is not of large dimensions. Its fruit is of the same size as a peach; the outer rind, which resembles somewhat the green rind of a walnut (although it is much thicker), is smooth, pulpy, and bitter, and about half an inch thick. As the fruit ripens, this outside covering bursts, and discloses a thin bright scarlet membrane, which appears as if torn into narrow branched slips. This membrane, when dried,

* This part is not, strictly speaking, the root of the plant, but a kind of underground stem; the true roots, which consist of fibres, grow from its under surface, and penetrate the ground.

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142. How many varieties are spoken of?
143. What is the difference between nutmegs and mace?
144. How are these spices prepared?

is mace. It grows round the nut, which consists of a thin, hard, dark-brown shell, enclosing an oily kernel, which is the nutmeg. The nutmeg-tree is largely cultivated for the sake of these spices. The fruit is gathered when ripe, the outer rind taken off, and thrown away. The mace is then carefully separated from the nut and dried. During the operation it loses its bright scarlet, and becomes of a reddish orange colour. It is then pressed into bags, and is ready for exportation. Mace, when good, is of a rather deep colour, very oily, with an agreeable aromatic odour, and a similar, though somewhat bitter taste. After the mace has been removed, the nuts are dried, first in the sun, and then over a fire, until the kernel has so shrunk as to rattle in the shell when shaken. The latter is then broken, and the kernels, which are the nutmegs, extracted. These are dipped in lime and water to preserve them, and exported.

WOODS.

INTRODUCTION.—On examining the stem or trunk of any tree, that is a native of temperate climates, we find it consists of three distinct substances. In the centre is situated a light, soft, and porous, or cellular body, called pith, which is so large in the elder that it may be readily examined. The use of the pith appears to be to convey the sap upwards to the leaves when the plant is very young, and before any other channels are formed for its ascent; as the plant increases in age, the pith becomes dry, and is, apparently, of no further use, and may be removed without any injury to the life or health of the tree. Surrounding the pith is the wood, which consists of tough, strong fibres, so closely united as to form a very firm, solid sub-

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145. What is the pith of trees, and its use?

stance. The fibres are placed side by side, and run in the direction of the trunk; they cause what is termed the grain of the wood, and when we cut a piece of wood *across* the *grain* we cut these fibres across; when we split it *with* the grain, we merely tear the fibres apart, that were before lying side by side. Every summer the tree forms a fresh quantity of wood around that of a previous growth; therefore it of necessity makes a circle, and on attentive examination of the trunk, when cut across, we may perceive that the whole mass of wood consists of a number of circles in succession; each of these circles has been the growth of one year, and by counting them we ascertain the age of the tree. The wood that was formed the first year is next the pith; that formed the second year of the tree's life is outside the wood of the first year, and so on a fresh circle is deposited every year outside those previously formed; hence the oldest, and usually the firmest wood in a tree is the centre, and this is called heart wood; whilst the youngest and softest is on the outside, and is called the sap wood, as it is through it that the sap rises to supply the branches and leaves. The uses of the wood to the plant are twofold: it gives great firmness and strength to the stem, enabling it to bear up the head of the tree, and to withstand the force of the wind blowing against it; it is also the channel through which the sap rises from the roots to be conveyed to the leaves and flowers. The uses of wood to man are immense, but they will be spoken of as each particular wood is described. On the outside of the wood protecting it, and serving also as a channel for the descent of the sap, is the bark, which is more particularly described under the head of Oak Bark.

Cedar-wood.—The cedar-wood used in this country at the present time is not, as its name would lead us to suppose, the produce of the cedar tree, but of a kind of juniper, a native of the island of Bermuda; the tree is too

146. Describe the wood and the grain of trees.
147. How is the age of a tree computed?
148. Describe the heart, sap-wood, and bark of trees.

tender to grow in the cold climate of England; like our common juniper, it has long, narrow, sharp-pointed leaves, and its seeds, instead of being contained in a cone, like those of the real cedar, are enclosed in a small fleshy berry.

The tree attains a very large size, and the wood is sent to this and European countries in considerable quantities. It is of a very fine close grain, but, at the same time, exceedingly soft and light. Its odour is agreeable and fragrant, and its colour a delicate slightly reddish brown. It is occasionally used by cabinet makers, but it is too soft for most purposes, being readily scratched by the nail. Its great use is for making pencils and pen-holders; to these purposes it is well adapted, by its lightness, and by the readiness with which it is cut, as well as by its agreeable colour and smell. It is occasionally used in the form of shavings to drive away moths; but a stronger odour, as camphor, is much more efficacious.

MAHOGANY.—The tree that yields this valuable wood is a native of the West India islands, and the central and warmer parts of America.

The tree is tall and straight, often rising to a great height before it branches out; it frequently measures above 100 feet to the top of the branches. The latter spread out on every side to a great extent, forming a very large head; the leaves are a deep shining green, and somewhat resemble those of the walnut; the flowers are small and whitish, their pearly appearance contrasting very beautifully with the deep colour of the foliage. The age which the tree attains is great, as it grows but very slowly—most probably it does not arrive at maturity under 200 years. The trees, when felled, are hewn into a square shape before shipped to this and other countries.

The wood yielded by the tree is of great value to the cabinet maker, partly from its great hardness, which renders it not so liable as other woods to be scratched, and

149. What of cedar-wood, and its uses?
150. Whence is mahogany obtained, and how does it grow?

enables it to take a fine polish. It is also valuable from its remaining straight when made into articles of furniture, it not being liable to warp or bend. Its colour also is dark and rich, especially when it is oiled or varnished, and it also readily receives a polish.

These desirable qualities have brought this wood into almost universal use as a material for furniture, and there are but few houses in this country which do not contain some article made of mahogany, though it is a native of so far distant a climate. When first discovered, the wood was used for building or repairing ships by the Spaniards; but its beauty being observed, it came rapidly into present use.

The bark of the tree has been used in medicine; but, though very astringent and bitter, its value is not equal to that of other barks more employed.

Oak-wood.—Oak-wood is the produce of several varieties of oak growing in different parts of the world. It is also yielded of a most excellent quality by the several kinds of oak which are natives of this country.

The wood is of a coarse open grain, but, at the same time, heavy, and exceedingly strong and tough. Hence it is of great value for all purposes where strength is required—as, for example, for spokes of wheels, the bars of ladders, and the framework of machinery; builders requiring wooden bars of great strength for roofs, &c. of large buildings, as cathedrals, usually employ oak, as there is not any wood so readily obtained that possesses its strength or durability; many of the roofs formed of it have lasted even hundreds of years. Oak resists the action both of air and water, and it is owing to this property, as well as to its strength, that it is employed in building ships of war—for which purpose it is well suited, by the power it possesses of permitting a cannon-ball to pass through it without its splintering, so as to form a large aperture.

151. Describe the tree and its uses.
152. What makes it so valuable?
153. Describe oak-wood and its uses.

[For this purpose, the live oak, which is abundant in Florida, is in high reputation.] The crooked branches of the tree also yield what are termed knees; these are the bent timbers placed inside the vessel to support the decks, and to strengthen the hull.

As the oak is not affected by moisture, it is generally employed for making tubs, casks, and pails, for which purpose its great strength also renders it serviceable.

PINE, or FIR-WOOD.—The different kinds of fir-wood, pine, or deal, are all the produce of various species of fir trees. Thus the Scotch pine, or fir, yields the red deal, used by carpenters, &c.; and the yellow deal, white deal, and pine are the produce of other fir trees.

All the various kinds of fir-wood are valuable, but none more so than the Scotch fir. The value of these woods depends on several circumstances; the trees being tall and straight yield planks, which are long and free from knots. The wood is also light and soft, so as to be readily worked by the carpenter or builder, and, at the same time, sufficiently strong to form beams and joists for houses, framework for machinery, &c.

It is from its holding glue better than most other woods, and being so readily worked, that it is selected by the picture frame carver, and by the cabinet maker; who, after that he has formed articles of furniture from it, covers them with a thin coating of mahogany, or rosewood, called veneer, which is glued on.

The various kinds of deal are valuable from their power of resisting decay; this is perhaps owing to the quantity of turpentine and resin that they contain. The wood seems saturated with these substances; and as they are not acted upon by water, they must serve to protect the wood from damp; so well is this known, that builders always cause the piles on which bridges are raised to be made of fir. The straightness, lightness, and strength combined in this

154. Why used for ships of war?
155. What of the pine or fir-wood?
156. Name its various uses.
157. Why is it so highly valued?

timber, cause it to be used for forming masts, yards, &c. to ships. It is fortunate for man that a wood so valuable should be abundant; we find, in the mountainous districts of all countries, pines in immense forests, from the coldest regions of Norway and Sweden, to the warm climate of the Holy Land ("Solomon got cedar trees, and fir trees, according to all his desire"); so that the wood most generally useful is the most easily obtained, and though in quality the most valuable, in price the least.

MISCELLANEOUS SUBSTANCES.

ACORN.—An acorn is the fruit, or ripe seed-vessel, of the oak. It consists of a hard cup, formed of small scales, firmly connected together, and an oval nut, which is joined at its base to the cup. The nut has a thin, light brown shell, which encloses the kernel, or seed. Before the acorn has become ripe, the cup entirely covers the nut, which it preserves from injury. As the nut grows its shell becomes hard, and it no longer requires the protection of the cup, from which it bursts forth.

The only use to which acorns are applied at the present time in this country is for the food of pigs. When the acorns are ripe, they fall from the oaks, and the swine are driven into the forest and eat them. The bacon and hams of the Hampshire pigs, which feed in the New Forest, are considered particularly excellent.

Before the birth of our Saviour, the original inhabitants of this country (the Ancient Britons) made acorns a large part of their food; and even now the inhabitants of Spain and Portugal eat the acorns which grow on different kinds

158. Describe the acorn, and its use.
159. When and how has it been used for food?

of oaks; they are, however, much less bitter than our acorns, and are really good food.

The squirrel, and other small quadrupeds, and some of our wild birds, feed largely on acorns.

The mode in which a plant bursts forth from its seed may be most beautifully and instructively shown by partially filling a hyacinth glass with water, fitting a card to the top, as a kind of lid, and from the card suspending an acorn *over* the surface of the water. After a few weeks the acorn begins to sprout, or germinate, and when some time has elapsed, a hole must be made in the card for the little tree to shoot through. This experiment should be performed in the autumn, when the acorns are fresh from the trees; and if the glass be kept in a warm room, the plant will live through the winter: it dies however in the spring, if not planted in the earth.

Chamomile Flowers.—Chamomile flowers are the produce of a plant common in many parts of England. It is a dwarf plant, with very finely cut or divided leaves; each flower head consists of a yellow centre surrounded by white leaves in the form of rays. All parts of the plant are intensely bitter and nauseous to the taste, especially the flowers, which have a rather agreeable aromatic odour. On account of possessing these bitter tonic properties, chamomiles are used as medicine, and are cultivated extensively; the flowers are picked and dried in the sun.

When growing wild, chamomile should not be confounded with the mayweed, a plant to which it bears a great resemblance; but which is distinguished readily by its erect branching stem, and very disagreeable and powerful odour.

Camphor.—Camphor is a vegetable substance, in appearance semi-transparent and colourless; solid, and easily broken, and yet at the same time so very tough that it is with

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160. What experiment is described?
161. Describe chamomile flowers and their use?
162. What of camphor, and its properties?

great difficulty it can be powdered, without the addition of a few drops of spirit or oil.

It is exceedingly volatile, and when exposed to the air it flies off in vapour.

Its smell is very strong and aromatic, and not easily mistaken if once known. On account of this strong odour, it is much used to preserve cabinets and clothes from insects and moths; it does not destroy them, but is so much disliked by them, that they will not frequent the situations where it is placed.

From its strong smell also has arisen the idea that it will prevent the catching of infectious disorders, and it is frequently carried by persons under this supposition; it is, however, much more hurtful than beneficial, as its effect on the system, though at first stimulating, becomes depressing, leading to slight headache and oppressed breathing, thereby rendering the disease feared much more liable to be taken.

Camphor dissolves in water only in very small quantity; sufficient however is taken up to give to the water both its aromatic odour and bitter taste. Water containing a small quantity of camphor dissolved in it, is known by the name of camphor julep.

A singular effect takes place if some very small shavings of camphor are thrown on the surface of *perfectly clean* water contained in a large basin; the pieces of camphor immediately begin to move rapidly, some turning round on their centre, and others moving from place to place: the cause of these motions is unknown.

Camphor is readily dissolved by spirits of wine: the solution thus made is called camphorated spirit; it is useful for rubbing unbroken chilblains, and for applying to burns and scalds when the skin is *not destroyed* or broken.

As a subject of an experimental object lesson, camphor is well adapted to develop several ideas; for instance, a small portion placed in water will show its sparing solubility. Another portion may be dissolved in spirit of any

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163. Name its various uses.
164. What singular experiment is named?

kind. If first coarsely powdered, its fusibility and volatility may be strikingly exemplified by placing a small piece in a spoon, and holding it over the flame of a candle. It first melts, and then rapidly volatilizes; and if allowed to come in contact with the flame, its inflammability is easily shown.

Camphor exists in many plants, but it is obtained chiefly from two trees; one a native of China and Japan, very much resembling the laurel. From this tree it is procured by chopping up the leaves, branches, root, &c. into small pieces, and placing them in a still with water; on the bottom of the still being heated, the camphor, from its volatility, rises in vapour, and collects again in a cold part of the apparatus. When brought to Europe, it is purified by a second distillation. The other tree from which camphor is procured is a native of Borneo and Sumatra; the camphor is obtained by splitting open the tree, when it is found in large pieces in the interior.

Cane.—Canes, or ratans, are the long slender shoots of a prickly plant which grows wild, in immense numbers, in the forests of the Malay peninsula, and the Eastern Islands, as Borneo, Sumatra, &c. The stems are cut by the natives, stripped of the outer skin by being pulled through a notch cut in a tree, and tied up in bundles of 100, being bent in the middle and the ends fastened together.

In this form they are exported in immense numbers to various parts of India, China, and Europe; to England alone many millions of ratans being brought annually. If a cane be examined, it will be found to consist of tough wood fibres, among which are a number of open tubes, which allow the sap to ascend with sufficient rapidity to supply the great evaporation that takes place from the leaves in tropical climates. On the outside the cane is covered with a transparent glazing, of extreme hardness,

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165. What of camphor, julep, and spirit?
166. Whence is camphor obtained, and how?
167. What of ratans, and where grown?
168. Describe canes, and their uses.

so that when two pieces are rapidly and forcibly struck together fire is produced.

For use, those canes are regarded as the best which are thin, very long, of a pale yellow colour, and so flexible as to bend without breaking or cracking the glazing.

The chief use to which they are applied in this country is, in forming the open lattice, or cane-work used for the seats of chairs, and similar purposes. When employed for this purpose, they are split into slender slips, the glaze being retained. These slips are woven, by hand, into the open work, which is well adapted to resist pressure, from the great strength of the material; whilst the extreme hardness of the glazing, which is placed on the side exposed, renders it very durable.

CHAFF.—Chaff consists of hay, dried clover, straw, or a mixture of these, cut small by means of a machine called a chaff-cutter. It is used as food for horses, being generally mixed with the corn that is given to them.

This name is also given to the husks of corn that are detached from the grain by threshing, and afterwards separated by winnowing. It is in this sense that the word is used in the Scriptures. The chaff of grain is used for stuffing common beds, and it is also thrown down in farmyards for litter.

COFFEE—RAW AND ROASTED.—Coffee is the seed of a small evergreen tree, or shrub, which grows to a height of sixteen or twenty feet. It is a native of Arabia and Abyssinia, but is now grown in very great quantities in the East and West Indies.

The evergreen leaves of the shrub are of a bright colour, and resemble, somewhat, in shape and size, those of the bay. The flowers are like the jessamine, and are brilliantly white; they open so rapidly, and are in such great abundance, that the trees at the time of flowering appear as if covered with snow, and at the same time emit a

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169. What of chaff, its variety, and use?
170. What is coffee, and whence obtained?

most delicious fragrance. Each flower is succeeded by a small berry, which attains the size of a cherry, and becomes, when ripe, of a dark red colour; it contains two seeds.

In Arabia the berries are gathered by placing cloth under the trees and shaking the branches, when the ripe ones fall off; they are then spread on mats and dried in the sun, and the husk removed by being crushed with a large stone roller. After this the seeds are again dried in the sun, and packed up in bales for exportation.

In the West Indies, as soon as the fruit is of a deep red colour, it is gathered by the negroes, who pick the ripe berries with their hands and put them into large bags hung about their necks. The berries are then either placed in the sun, in layers, about four inches thick, when the pulp ferments, and dries in about three weeks; or they are at once crushed in a mill, which bruises the pulp, but not the seed; the former is then washed away, and the coffee dried.

Coffee, of which the beverage so called is made, is the seed of the berries. The form of the seed is convex or curved on one side, and flat on the other; the latter being deeply grooved. In this raw state it is of a pale brownish yellow, and has but little taste or smell. When roasted in a close iron vessel, placed over a slow fire, it acquires a dark chestnut colour, and each seed increases very much in size; from being nearly tasteless and inodorous, it becomes bitter and crisp, and gives out a powerful aromatic smell.

This roasted coffee is made into a beverage by infusing it in boihng water, or by boiling it. When the latter mode is employed, care should be taken to boil it a very short time, for if long on the fire, the aromatic flavour is dissipated, and the bitter principle alone remains.

Coffee is a stimulant, and a preventive of sleep; if made very strong, and taken at night, as it frequently is by persons engaged in literary pursuits, it retards the accession of sleep for several hours.

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171. Describe the manner of gathering it.
172. What is said of its nature and properties?

Cork.—Cork is the bark of an evergreen oak, which grows abundantly in Spain, Portugal, and the south of France.

In order to remove the cork, a long cut is made down the tree, at the two ends of which incisions are made round the tree; the bark is then removed by an instrument inserted under it. If the operation is carefully performed, the cork tree is not injured, as the part of the bark which is taken is really dead; but the inner bark cannot be removed without killing the tree.

The cork is first taken from the tree when it is about fifteen years old, and the operation is repeated every eight or ten years, as long as the tree lives, which is usually about 150 years.

After the cork bark is taken from the tree, it is slightly charred, or burnt. This improves it by closing the pores; but at the same time blackens it, and gives it a burnt odour, which it sometimes communicates to the liquors with which it comes in contact. After being pressed flat, it is tied up in bundles and exported.

Cork possesses several qualities that render it very valuable. It is extremely light, hence it is used to float other bodies in water; as when used as floats to fishing nets; for cork jackets to support persons in the water; and also for life-boats.

Cork is extremely compressible and elastic. These qualities fit it admirably for stopping the mouths of bottles containing fluids; as, when pressed firmly in, its elasticity causes it to press so closely on all the parts of the mouth as to prevent the contents of the bottle from escaping, or the air from entering. Cork is also used to form the inner soles of shoes and boots; whilst it keeps out the wet, it adds little to the weight.

Cork is brought to this country in an unmanufactured state, and is cut into the shapes and sizes required, by men

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173. Whence is cork obtained, and how?
174. What of the age of cork trees?
175. Name the various uses of cork.

called cork-cutters; the knives they use are extremely sharp, and require to be frequently whetted.

CURRANTS.—The foreign, or grocers' currants are small raisins, or dried grapes, which are grown principally in the Grecian Islands. The name of currant has probably been given them from the resemblance, in size, to our common American fruit of that name. They are destitute of stones, and of a dark reddish-black colour. When first gathered their flavour is extremely delicious.

These small grapes are gathered from the vines in August, and spread out on earth which has been stamped hard, and left until the sun has dried them, when they are closely pressed into warehouses, where they remain until they are dug out and packed in casks for exportation.

They are so much used for various purposes, that above 6000 tons annually are imported into England.

FIG.—This fruit is the produce of the fig-tree, a plant originally a native of the south-west of Asia, but which is now also cultivated abundantly in all the countries in the south of Europe.

The tree is of small size, and bears a large leaf, which is so deeply notched as to be partially divided into several lobes. There are not any visible flowers, but the fruit arises from the stem, in the form of little buds; these are pear-shaped, and appear to be pierced at the large end with a small hole. They continue to enlarge in size till they become the ripe fruit, retaining their original pear-like shape.

If one of the unripe buds be cut open it will be found to be hollow, and the inside to be covered with numerous small points; these are the real flowers, which are thus enclosed in the fruit. Before it is ripe the fig abounds with a bitter milky juice; in the ripe fruit this is converted into sugar.

The tree is easily cultivated in this country, if protected

176. What are currants, and whence derived?
177. How are they prepared for exportation?
178. What of the fig-tree, and its fruit?

from severe cold; but its green fruit is not much valued, as it does not arrive at perfection in our climate.

In the East, figs are a most important article of food, both in their fresh aud dried state.

One of the most valuable qualities of the plant is its bearing ripe fruit three times in the year.

In the Scriptures we find frequent allusions to its utility. The Old Testament contains many passages respecting the value set on it; and the failure of the crop was regarded by the Jews as a very serious calamity. We find its treble crop of fruit alluded to. Hosea says, "I found Israel like grapes in the wilderness; I saw your fathers as the first ripe in the fig-tree at her first time."

In the Levant, from whence most of our figs are obtained, the first crop ripens in June. The summer crops then begin to form; it is this which is dried, and packed in boxes and baskets, and sent to various countries: about 1000 tons are yearly brought to us. After the summer crop has ripened, there appears a third crop, which often ripens on the tree after the leaves are shed, thus supplying the inhabitants with fresh fruit during a great part of the year.

Gum Arabic.—Gum Arabic is the produce of several kinds of acacia trees, which are natives of the sandy deserts of Africa, and the East Indies.

When the bark of these trees is wounded, a liquid oozes out, which hardens in semi-transparent lumps; and this is the gum generally known by the name of gum Arabic.

Similar lumps of gum may be obtained from the plum and cherry tree of our gardens; when a rupture is made in the bark, this mucilaginous substance oozes out.

The use of gum depends on its ready solubility in water, and its adhesiveness when melted. The solution of gum, or gum-water, as it is usually called, is much used for sticking light and thin objects together, fastening labels on glass, or for any delicate work; but not where great tena-

179. Name the peculiarities here cited.
180. Whence, and how, is gum arabic obtained?
181. Why, and how, is it useful?

city is required. It is also employed extensively in the arts, in stiffening crapes and other fabrics, and in the manufacture of ink.

Hops.—Hops are the produce of a coarse, rough, climbing plant, which attains the height of several feet, twining for support round the hedges or poles near which it grows. It is furnished with opposite heart-shaped leaves, toothed like a saw at the edge, and extremely harsh to the touch, from the presence of minute points or hairs.

The flowers are of two kinds, barren and fertile; both are of a pale green colour; the former being small and grouped together; the latter, or fertile flower, consists of thin green scales, each of which covers a single seed-vessel containing one seed. These seed-bearing flowers are collected together in cone-shaped heads, which increase in size; and, when ripe, form the substance known to us under the name of hops. The inner surface of these scales, and the surface of the seed-vessels, produce a powdery substance, in which the bitter principle of the hop chiefly resides.

The hop grows wild in many parts of England and America, and it is cultivated in fields called hop-grounds. Long poles are placed at the root of the plants in the spring, and as the plants grow they twine round them, hanging in beautiful festoons. At the hop-picking season the poles and the plants are taken up and laid across large baskets, into which the seed-vessels are put. At this time most of the labouring people of Kent, in England, are employed in hop-picking, from the smallest child to the aged men and women.

The great use of hops, and the purpose for which they are so largely cultivated in England, is as an ingredient in making beer. Their utility depends upon their bitterness, which gives to the liquor an agreeable taste, and wholesome properties, and upon their strong aromatic flavour; whilst the presence of a considerable amount of

182. Describe hops, and the manner of their growth.
183. What of the flowers of hops?
184. Where and why are the hops cultivated?

astringency stops the fermentation of the beer, and prevents it turning sour.

The hop is valuable as a medicine, from its strengthening and tonic properties.

INDIAN RUBBER.—This substance is the produce of several trees, which are natives of the warmer parts of South America.

It is obtained by making incisions in the bark during the rainy season, when a thick milky juice, of a yellowish-white colour, flows out. If this juice is at once corked up in bottles, it will remain some time without undergoing much change; but if it is exposed to the air, it soon dries, and becomes the substance we call Indian rubber.

The natives of South America spread the juice, as it flows from the trees, on moulds of clay, and as soon as one coat is dry, they apply another, and so on, until it has acquired sufficient thickness. They hasten the drying by placing the moulds over a wood fire, the smoke from which blackens the Indian rubber, which would otherwise be white. The clay moulds on which the soft juice is spread, to harden, are usually shaped like a large pear; when the whole is dry they are easily broken and the pieces removed, and the Indian rubber is left in the form of a hollow bottle.

Indian rubber, as we receive it in this country, is a soft, pliable, and highly elastic substance; tough, and difficult to be cut. Its elasticity is much increased by warmth; and, on the contrary, if allowed to remain long undisturbed in the cold, it is much diminished.

If heated considerably, India rubber melts, but it does not become solid again on cooling. If set fire to, it burns with a white flame, gives out much smoke, and a peculiar odour. It is quite insoluble in water, and even in spirits.

Indian rubber is a substance of great use, not only to the natives of the climates where it is produced, but to us and other nations. The inhabitants of South America

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185. Whence and how is Indian rubber obtained?
186. How are the bottles we see prepared?
187. Name the properties and uses of Indian rubber.

form water-proof boots, by spreading the milky juice of the tree, before it hardens, on cloth. They also use the bottles into which they first shape the substance, and they make torches of it.

In this country and in England, it was for many years only used to rub out the marks of black-lead pencils, and from this circumstance it took its name; but a late discovery, that a fluid obtained from coal tar dissolves it, and on drying leaves it unchanged, renders it an article of extreme utility.

This dissolved Indian rubber is now used for many purposes. Water-proof, or "Macintosh" cloth, as it is called, from the name of the inventor, is made by spreading the dissolved Indian rubber on a piece of cloth, pressing another piece on it, and passing the whole through rollers. In a short time, the coal tar naptha flies off, and leaves the two pieces of cloth firmly connected together by the interposed Indian rubber. The fabric is quite water-proof, and even air-proof, so that bags of it may be blown up like a bladder, and used as pillows or cushions. Its great use, however, is in making water-proof caps, cloaks, and great coats. The dissolved Indian rubber is also used, instead of glue, in binding books, and it holds the paper so firmly that threads are not required. Water-proof shoes are made of Indian rubber, thin sheets being formed to the shape of the foot. It is also much used in surgical apparatus, for forming elastic bandages, &c.

Ink.—Writing ink is an opaque, black liquid, much used for writing on paper, parchments, &c.

The principal ingredients used in making ink are, green vitriol, or sulphate of iron, nut-galls, gum, and water.

The nut-galls, coarsely powdered, are usually boiled in a part of the water first, so that the latter may dissolve out all their astringent particles. To this liquid, when strained, the gum and the green vitriol, previously dissolved in water, are added; a chemical change immedi-

188. What agent dissolves it, and what is Macintosh cloth?
189. Name the various purposes to which it is applied.
190. Of what ingredients is black ink made?

ately takes place in the mixture, and a black colour is produced, which is insoluble in water, and would sink to the bottom if the gum were not present to thicken the ink, and so suspend the colour. The colour of ink is not very deep when first made, but it becomes much darker on exposure to the air for a few days.

In the wholesale manufacture of ink, logwood and blue vitriol, a preparation of copper, are both frequently added, to improve the colour. The use of the latter is attended with two serious inconveniences; it causes the ink to act on steel pens, and penknives, coating them with copper and rapidly spoiling them; and what is even still worse, it renders ink exceedingly poisonous; for these reasons, though it much improves the colour of the ink, it is better to omit it.

[Red ink is made by boiling Brazil wood in vinegar, and then adding alum and gum.

Blue ink is made by dissolving indigo in oil of vitriol, mixing it with water, and adding a little potash or soda. Prussian blue and oxalic acid are sometimes used.]

Mustard Seeds.—The mustard in common use is the seed produced by two annual herbaceous plants with yellow flowers, the four petals of which are arranged in the cross-like form, so characteristic of the wholesome and generally pungent tribe of plants to which they belong (the cruciform).

Both the plants are natives of England. The seeds of one plant are pale yellow, or nearly white; hence it is termed white mustard, and the plant producing them is chiefly cultivated for small salad. Those of the other are dark reddish brown—the plant bearing them is called black mustard. The latter kind is chiefly used, the seeds being much more pungent than those of the former. It is cultivated very extensively in the counties of Durham and Yorkshire. The seeds are sown either with the drill, or by the hand broadcast, in March or April, after the ground

191. Why should copper be omitted?
192. How is red and blue ink made?
193. Describe the two plants which yield mustard seed.

has been prepared by ploughing and harrowing. When the plants are a few inches high, they are thinned by hoeing, and in August or September, when the small yellow cross-shaped flowers have faded, leaving the seed vessel and seeds fit for gathering, the plants are cut down and tied in sheaves.

In preparing mustard for use, the seeds are ground in a mill, and the dark-coloured husk separated by fine sifting. Ground mustard, or flour of mustard, as it is sometimes termed, when mixed into a paste with water, forms the well-known condiment that is used to flavour our food, and to quicken digestion by stimulating the stomach to more rapid action.

Ground mustard also forms an extremely useful and safe emetic where poison has been taken; a large table-spoonful of the powder in a glass of water acting immediately. It is also used to aid the effects of hot foot-baths, as by its stimulating properties it causes a great determination of blood to the skin from any affected part.

White mustard is cultivated for salad, the young plants being cut when about two inches high. Some years since the seed was much used as a cure for many complaints, when swallowed whole in water; but its use was much more injurious than beneficial.

It may be mentioned that the mustard plant, though produced from so small a seed, attains a large size in hot climates, and was hence chosen by our Saviour as a subject for one of the parables—Matt. xiii. 31; Mark iv. 30; Luke xiii. 18. As, however, it does not become a tree, it is supposed by many writers that another plant was alluded to.

Nutgalls.—These useful substances are the produce of a small shrubby oak that grows abundantly in all the countries of Asia Minor. Its stature is so low that it ought to be considered as a shrub rather than a tree, not attaining a greater height than six feet. The nutgalls,

194. What difference between white and black mustard?
195. Name the various uses of mustard.
196. What are nutgalls, and how produced?

although produced on the plant, are not its fruit (which resembles that of our oaks, being acorns), but are caused by a small insect, which pierces the bark of the young shoots, and deposits its egg in the hole; the presence of the egg causes a swelling to take place, which is the gall. The eggs are hatched in the gallnuts, they become larvæ or grubs, and feed on the substance of the gall that contains them; after a certain time they turn to the perfect insects, which soon gnaw their way out, leaving a small hole in the side of the nutgall. On looking at a number of galls, we find that some are pierced with this round aperture, whilst others are not—the latter are considered the most valuable in commerce; if broken, they will be found to contain the remains of the grub, or not unfrequently the perfect insect. Galls are in perfection when they have arrived at their full size and weight, yet before they are pierced by the insect. They are gathered by hand for sale. Of all vegetable substances, nutgalls are by far the most astringent. This we might be led to expect, as they are produced from the juice of the oak, which abounds in astringent matter. (See Oak Bark.)

They are used in the manufacture of ink, as they have the property of producing a black colour when mixed with green vitriol (a preparation of iron). They are also used in dyeing cloths black and other colours, and also occasionally in medicine.

Oak Bark.—The stems of trees growing in temperate climates have a covering called bark; this not only protects the growing wood, but serves as a channel down which the sap that has been prepared in the leaves descends. This descending sap, having been exposed in the leaves to the action of the sun and air, is charged with the peculiar products of the plant; and as it descends by the bark, this last is also highly charged with them. It is from this circumstance that the bark is selected in preference to the wood, when we wish to obtain the peculiar principle of any plant. The bark of the oak, therefore, contains a

197. Of what use are they in the arts?
198. What is the nature of oak bark?

much larger proportion of the astringent matter of the plant than the wood. Its great use is to convert hides into leather; it is carefully removed from the tree, and is then ground into a coarse powder between iron rollers, and placed in layers between the skins in the tan-pit. The skins of animals consist in a great part of a substance similar to glue, which is soluble in water, and very perishable. When this is acted upon by the astringent part of the oak bark, the two unite and form the insoluble and durable substance called leather.

After all the astringent part of the coarsely powdered oak bark has been absorbed, the refuse is used sometimes to keep up the heat in hotbeds, for as it gradually decays it gives out a mild warmth; and at other times it is pressed into a solid mass, dried, and sold for burning as a kind of turf.

Much more oak bark is used in England for tanning hides than their own oaks will supply; therefore large quantities are imported from the Netherlands, Germany, and other countries. [In the United States, the use of oak bark for tanning leather is immensely great, and the mills for grinding it are generally wrought by steam engines.]

Olive Oil.—This liquid is the produce of the fruit of the olive, which is crushed when fully ripe, and the oil pressed out. Thus obtained, it is a pale yellow liquid, with a bland oily taste, and destitute of smell. In the warm countries of the south of Europe and Syria, of which the olive is a native, the oil has been in use from the earliest periods of which we have any record (Exod. xxvii), both for burning in lamps and for food. For these purposes it is well adapted; it is readily inflammable, and burns with a clear flame and without smoke: and from its being without any unpleasant odour, and not being liable to turn rancid, it is much used for food.

Another use to which olive oil was applied in the East was for the purpose of making ointments, which were

199. What property does it possess, and of what use?
200. Whence and how is olive oil procured?

used in anointing; these were made of spices of the most expensive kind, mixed together with oil. In England and this country, at the present time, oil is used for food and for the preparation of medical ointments, &c.

Oils of a cheaper kind, obtained from animals, as the whale and seal, are used for burning in lamps. [Lard oil is becoming an article of extensive use in lamps, all over the United States.]

Another important use of oils is for the purpose of making paint: when mixed with chemical substances of a drying nature, and exposed to the air, they become hard and dry; and if in this state they are laid on wood, &c., they form a kind of varnish that perfectly resists the dampness of our climate, and much preserves the wood. When white lead is added, so as to render the mixture perfectly opaque, it is called paint, and various colours are generally added to produce the tints required.

Olive oil, from its great price, is not usually employed for making paints, but that prepared from the seeds of the flax or linseed. (See LINSEED.)

PAPER.—This valuable material is manufactured almost entirely from various kinds of rags. In England and the United States, so great is the demand for rags for this purpose, that they are imported in immense quantities from Italy, Germany and other parts of Europe. The first operation in making paper is the sorting of the rags according to their various degrees of fineness, and at the same time they are cut into small shreds; these shreds are then beaten and shaken in a machine, so as to free them as much as possible from dust and dirt. The rags are then washed, and afterwards ground to a pulp in water, by means of a machine of rather a complicated construction; it consists of a large cistern to contain the water and the rags to be converted into pulp. In this cistern turns round with immense rapidity a cylinder like a drum, from the sides of which project a number of blades or cutters; these,

201. What are its properties and uses?
202. What oils are now used for burning?
203. To what use is flax or linseed oil applied?

as the cylinder turns round in the water, have their cutting edges brought close to those of another set of cutters fixed to the cistern, and as the rags are caught between the knives they are rapidly cut or torn up, and reduced to a pulp, which is whitened by the addition of chloride of lime. (See CHLORIDE of LIME.)

This pulp being again well beaten, so as to render it exceedingly smooth, is mixed with some size or thin glue; and for the manufacture of some papers a small quantity of blue, as indigo, is added.

Formerly, from the pulp thus prepared, the paper was made by hand; but latterly by far the greatest quantity is made by a machine, propelled by water or steam.

In the former case, the paper was made in sheets the size required for use, but by the machine in pieces of immense length—viz., from twenty to thirty feet, and five feet in breadth. It is stated that the machines now at work in Great Britain make nearly 2000 miles of paper four or five feet broad every day. The formation of the machine is very complicated, and could not be understood without the aid of engravings; therefore the mode of making paper by hand will be described, the principle being the same in both cases; for whatever plan is adopted, the object is to separate from the pulp the water it contains, and to cause the former to assume the shape of a sheet of paper. The worker stands by the side of a vat containing the pulp well mixed; into this he dips a kind of sieve called a mould, on which he takes up a small quantity of pulp; this sieve is formed of wires, the arrangement of which varies with the kind of paper required: for foolscap, the wires are separate and run parallel, giving that paper its peculiar ribbed appearance. Wove paper is so called from the sieve or mould being formed of wires woven into a fine cloth, with about fifty or sixty meshes to the inch.

Usually the maker's name and the date are marked on the mould by sewing in a piece of wire in the form of the

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204. Of what is paper made, and what of the pulp?
205. Describe the process of paper making.

letters required; this being raised above the surface of the mould, makes the paper thinner at these parts. The pulp taken into the mould is, by shaking, spread very evenly over the whole surface, and the water drains away through the wires; when so much of the water has drained off as to leave the pulp tolerably firm, it is turned out on a piece of felted cloth, and upon it another piece of felt is laid to receive a second layer of half solid pulp; and so on alternately pulp and felt until six or eight quires are piled up. The whole is then pressed by machinery, with a pressure equal to or exceeding 100 tons; by this immense force much of the water is driven out, and the paper becomes much more solid. Removed from the press, the felts and paper are separated by a boy, the former being again ready for immediate use. Two men working at the vat, and a boy to separate the felts and pressed papers, can make six or eight reams a day.

In the evening, the whole of the paper made during the day is placed in a press, where it remains all night; this somewhat smooths the surface, and gets rid of more of the moisture. It is then separated and hung on ropes to dry.

From the drying room it is removed to be sized; this is accomplished by dipping about four quires at once into a kind of size or thin glue (see GLUE), each sheet being moistened equally. The whole is once more pressed, and again dried slowly for some days. The paper is now finished, with the exception of pressing once or twice, so as to give it a smooth and even surface. It is then sent to the finisher, who counts the sheets into reams and does them up; so great is the rapidity acquired by practice, that a good finisher will count 200 reams, or 96,000 sheets a day.

Several kinds of paper are made from various materials, as they are required to answer different purposes.

Brown paper, in use for packing up heavy articles, is made from canvass, sackcloth, and other strong hempen materials. Whity brown paper is a cheap paper used for

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206. How is paper sized and finished?

wrapping up small articles; is made thin, and of rather finer materials.

Blotting paper is made without being much pressed, and is not sized; so that it is porous and very absorbent, readily sucking up, like a sponge, the superfluous ink from writing—the pulp for this paper is usually coloured in making.

Foolscap is a paper of large size, made on a mould whose wires are parallel. Letter or wove paper, is formed on a mould of closely woven wire gauze. It is sometimes left white; at others dyed, when in a state of pulp, with indigo, or a dye called smalt; this is called blue, the other yellow, wove.

Hot pressed or satin paper is merely the best Bath or letter paper, sheets of which are placed alternately between very smooth pasteboards, and between every fifty pasteboards a hot sheet of iron is put; the whole is then pressed with immense force, when the warmth from the iron penetrates the pile, and with the pressure gives an exceedingly smooth surface to the paper. Silver paper is a very thin paper used for ornaments, and usually made without much size.

Pasteboard and card consist merely of several thicknesses of paper pasted together, and made to adhere by being firmly pressed together.

Pearlash.—Pearlash is an alkaline substance obtained from wood ashes. The great supply of pearlash for England is from America, where the trees are often cut down and burnt, solely for the purpose of manufacturing this article. The ashes of the burnt timber are collected and put into cisterns; water is poured upon them, which dissolves all the soluble parts of the ash, and, after standing some hours to become clear, is drawn off and evaporated to dryness in iron pots, when the half-melted pearlash remains.

It is brought to England in casks, containing about five hundredweight.

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207. What varieties of paper are cited?

Pearlash obtained by this process is usually of a grayish colour, from the presence of impurities; but it is readily freed from these by dissolving it carefully in water, and evaporating the clear liquor.

Pearlash, when pure, is a white substance of an acrid caustic taste, easily soluble in water; with which it has so great a disposition to unite, as to attract it from the air, unless it is kept in closely corked vessels or casks. It is an article of great importance in many of our manufactures. Soft soap is in part composed of it; many kinds of glass are made by its aid (see GLASS). It is also used by scourers in cleaning wool, &c.; and its use in removing grease and scouring wood-work, paint, &c. is very great; although it is now not so much employed for these latter purposes as soda, a substance somewhat similar in properties, but much cheaper in price.

Soda (which does not attract moisture from the air) is prepared by a complicated chemical process from common salt.

RAISINS.—Raisins, or dried grapes, are the produce of the vine. This plant, although now cultivated in all the warmer regions of the globe, was originally a native of Asia, from whence it spread into Europe, Africa, and even the New World.

The grapes of Palestine are now, as well as in the time of Moses, of a larger size than those of other countries.

Although the vine is grown in England, and the grapes are eatable, yet they do not arrive at perfection. Wine, for instance, cannot be made from them without the addition of sugar. Neither is the sun powerful enough to dry them so as to form raisins. We are dependent, therefore, on other countries for this dried fruit.

In Valencia, from whence our great supply is obtained, raisins are formed by cutting the bunches of grapes, dipping them in a kind of lye made of wood ashes and lime; the lye is heated, the grapes are placed in a vessel full of

208. What is pearlash, and how produced?
209. For what is it useful in the arts?
210. What are raisins, and how procured?

holes, and the whole put into the hot lye; the grapes are then taken out of the vessel, and spread out on leaves placed on the ground, when they are rapidly dried by the heat of the sun.

The raisins called Malaga raisins are dried without being dipped in lye; hence their different appearance and flavour. The effect of the lye is to soften the skin of the fruit, and to render it less tough; whereas those dried without being dipped have tough skins, but the flavour is much superior. Hence Valencia raisins are used for pastry, the others for eating raw.

SAFFRON.—Saffron is the produce of the purple crocus, a plant much cultivated in our gardens for its beauty, and growing wild in many parts of England, but originally brought from the East.

The leaves appear in the spring, whilst the plant does not flower until the following September. Each flower consists of a long tube, expanding at the top into six purple petals. In the centre of the tube grows the style, which is a slender, bright orange-coloured stalk, divided at the top into three stigmas, which are the thread-like bodies that form, when dried, the substance called saffron.

To obtain this substance, the flowers are gathered early in the morning, before they open; the stigmas are picked out of them and carefully dried, by being spread out on horse-hair cloths over a stove. The saffron obtained in England is superior to the foreign. The best is dried in loose fibres, when it is called hay saffron. The inferior kinds are pressed into flat cakes.

Saffron is distinguished by a peculiar aromatic odour, and a slight bitter taste. It is used to colour and flavour pastry, and as a dye. When thus employed it is soaked, or boiled in water, which extracts both its fine yellow colour and its flavour, and may then be used for the purposes required.

It was once much used in medicine, but is not now highly esteemed. A plant bearing the somewhat similar

211. What varieties of raisins are named?
212. Describe saffron and its source.
213. What are its properties and uses?

name of "Meadow saffron, or Colchicum," is much used in medicine; care should be taken that it is not confounded with saffron, as its roots and seeds, the part employed, are exceedingly poisonous, and have frequently proved fatal.

SAGO.—The nutritious food, known to us under this name, is the produce of a palm-tree growing in low marshy situations, in the peninsula of Molucca, and the adjacent islands.

The sago palm grows to about 25 or 30 feet in height; the trunk is thick and cylindrical (not tapering), destitute of branches, and bearing on its top a tuft of numerous leaves before the tree forms its fruit. The stem consists of a thin hard wall or shell outside, about two inches in thickness; the whole of the inner part of the trunk is filled with an immense quantity of a pithy substance, from which the sago is obtained. This pith disappears as the fruit ripens, the latter deriving its nourishment from the pith, and when the fruit is quite ripe the stem is merely a hollow shell, or cylinder.

The inhabitants of the Moluccas, to whom sago is the staff of life, obtain it by cutting down the tree close to the ground, splitting up the trunk, and taking out the pith, which they rub to powder and mix with water; after straining off, the water is left standing; the sago settles at the bottom, and after a few more washings it is fit for use; but before it is sent to England it is again wetted with water, so as to make a paste, which is rubbed or rolled into the small grains we are acquainted with.

The quantity of sago yielded by each tree is immense; 500 or 600 pounds is a common produce for one palm.

Sago is a nutritious, wholesome food, of a starchy nature, light, and very easy of digestion, so that it is frequently used by invalids. It is now much employed as an article of food in England, being valuable from its cheapness, and its wholesome properties. Many hundred tons are annually imported into England. [In America it is only used as nutriment for the sick.]

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214. What is sago, and whence procured?
215. What of its abundance and uses?

SEALING-WAX.—This is a substance employed for fastening letters and papers. Its use depends on the readiness with which it melts; on its adhesiveness when melted, which is sufficient to enable it to stick very firmly to paper, but not so great as to fix it to a polished seal; on its plastic nature, when fused, which allows it to receive any impression stamped upon it; and as it hardens when cold, it retains the image impressed upon it.

Sealing-wax, possessing these properties, is prepared from a resinous substance termed shell-lac (which is the produce of an insect, a native of the East Indies), melted with about one quarter of its weight of Venice turpentine, and coloured red by vermillion, or sometimes black, by lamp-black. These ingredients are all melted together, and well mixed by stirring; and, while still soft, either cast into moulds of the shape desired, or rolled into round sticks, on a smooth marble slab.

A cheaper kind of sealing-wax is made with resin and red lead, for sealing over the corks of wine-bottles, &c. &c.

SODA.—Soda is an alkaline substance, well known to all from its great use in washing. Until a few years since soda was obtained from the ashes of burnt sea-weed, in the same manner as pearlash is now procured from the ashes of land plants (see PEARLASH): and not many years ago 20,000 persons were employed in the Orkney Islands alone, in collecting and burning sea-weed for this purpose.

At the present time soda is obtained from sea salt by a very complicated chemical process, conducted on a most extensive scale, in manufactories in the northern parts of Britain, and in such abundance is it produced that it is sold retail at 1½*d.* per pound. As thus obtained, soda is usually in large crystals, which are transparent, readily soluble in water, and have a cooling, alkaline taste. They contain nearly two-thirds their weight of water, and if gently heated they melt.

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216. Describe sealing-wax and its properties?
217. How is it made and coloured?
218. What is soda, and how was it formerly obtained?
219. Whence is it now procured, and how?

If the crystals of soda are kept in a warm, dry place, the water they contain flies off, and a dry white powder is left, less than half the weight of the crystals.

Soda is an article of very great value in various arts; all the different kinds of soap (with the exception of soft soap) are made with fats, or oils, and soda (see SOAP). Its use in cleansing from dirt and grease, both clothes and wood-work, or paint, is well known. A small quantity placed in what is termed hard spring water will render it fit for washing, or boiling vegetables.

It is also a substance of considerable value in medicine.

SUGAR.—The sugar used in England and America, both that called moist and the refined, is the produce of the sugar-cane, a native, originally, of the East Indies, but which is now extensively cultivated in the West Indies, the Brazils, and in the southern portions of the United States, &c. &c.

The stem of the sugar-cane is jointed, and without branches. It rises erect to the height of ten or twelve feet. The leaves, which are very long and narrow, rise singly from the joints, and they sheath or embrace the stem to the next joint above, like the leaves of our grasses. The top of the stem ends in a loose bundle of small downy flowers, of a very pale lilac colour, and about two feet long, giving to the plant a most elegant appearance. In the West Indies these blossoms are not seen, as the plant is cut down before they make their appearance.

The sugar-cane is always cultivated by sowing cuttings, the top joints being selected for planting, when the cane is cut down. The planting of the cane does not require to be renewed yearly; as, if the roots are left in the ground, fresh canes spring up for several years.

The sugar-cane, whilst growing, is subject to several injuries. They are sometimes destroyed by millions of small insects, that live on the juice; and, at other times,

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220. What are its properties, and uses?
221. Whence is sugar chiefly derived?
222. Describe the sugar-cane.
223. How may the sugar-cane crop be lost?

they are subject to the depredations of monkeys and rats.

When the canes are fully ripe, which usually is the case in March, they are cut down near the ground; and then, being divided into convenient lengths, are tied up in bundles, and conveyed to the mill, where they are crushed, and the juice squeezed out, by passing them between large iron rollers. The juice is immediately collected in a cistern, and boiled, with the addition of some lime, or lime-water, the use of which is to promote the separation of the impurities, in the form of scum, which rises to the surface, and is skimmed off. The clear liquor is then rapidly boiled, in order to thicken it, and to enable it to form into grains on cooling; when it is placed in hogsheads, in which it is sent to Europe. These casks have their bottoms pierced with holes, in order that the molasses, or that portion of the sugar that will not crystallize, may drain away, whilst the raw or moist sugar remains in the cask. The fuel used in boiling down the juice is the crushed cane, dried by exposure to the air. It is calculated that 110 canes will yield about five gallons of cane juice; and this quantity, boiled down, produces about six pounds of crystallized sugar. The molasses which drain from the casks and the scummings of the boilers are collected, and, being fermented and distilled, yield the ardent spirit known as rum.

Raw or moist sugar is converted into lump, loaf, or refined sugar, by a process termed refining. This was, until lately, performed by boiling it with white of eggs, blood, &c.; but now the art of refining sugar has wholly changed, and much more cleanly and improved means are employed.

The raw or moist sugar is first dissolved in water heated by steam, lime-water being added at the same time; the liquor is then filtered through thick folds of cloth. By this process it is freed from many impurities, and becomes transparent, although it is still coloured. The next stage of the process is the discolouration of the syrup; this is

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224. Describe the process of making sugar.
225. What of refined sugar, and how prepared?

effected by allowing it to filter through beds or layers of animal charcoal, or bone-black, formed by heating bones in close iron vessels. This substance has the property of separating and retaining the colouring matter of the syrup, which passes through the filter perfectly colourless. It is then pumped into covered boilers, and, by the aid of steam, is boiled down, or concentrated at a low temperature. This boiling down is continued until part of the sugar becomes solid; it is then poured into iron moulds of the well-known sugar-loaf shape. On cooling, it becomes a solid mass of sugar; a small hole is then opened at the bottom of the mould, and a small quantity of impure syrup drains out; this is the substance sold as treacle.

Loaf sugar, as thus obtained, is a granular substance, formed of a number of small white and hard crystals adhering together. If pure, it has no smell, and its taste is simply sweet, without any other flavour. It is readily melted by heat.

As an article of food, sugar is exceedingly wholesome and nutritious. It is noticed, that during the making of sugar the negroes in the plantations, and even the horses and cattle which are fed on the green tops and refuse, grow fat and strong, though their labour is at that time much increased.

The general uses of sugar are well known. Sugar candy is formed by allowing a hot concentrated syrup to cool slowly, when it forms large crystals on threads placed in the liquor. Barley sugar is merely sugar melted by heat and cast in moulds.

[Sugar is also manufactured from the juice of the maple tree in various parts of the United States, particularly in Vermont, and also in Canada. The trees at the proper season are bored with an auger, to the depth of two inches, and a piece of hollow cane inserted, to allow the sap to flow into vessels placed below for receiving it. Twenty or thirty gallons may be obtained from an ordinary tree, yielding some five or six pounds of sugar by boiling.

226. Describe loaf sugar, and how made?
227. Name the sources of sugar, other than the cane.

With suitable refining, very excellent sugar may thus be procured.

In France the sugar beet yields sugar of so good a quality that it is supposed to be used exclusively by half the population. The white beet is preferred, and more than 400 manufactories of the article are in operation.

Sugar is also obtained from the juice of the palm-tree, grapes, turnips, parsnips, starch, and potatoes.]

TEA.—Tea is the produce of an evergreen shrub, a native of China, Japan, and some parts of India. The leaves, which are lance-shaped, somewhat like those of the myrtle, are serrated, or toothed like a saw at the edges, and, when fresh, are of a bright deep green. When full grown their length is about two inches. The flowers are small and white, and are succeeded by a seed-vessel, or dry fruit, divided into three cells, each of which contains a single seed. The plants are raised from the seeds, two or three being dropped into the place where the shrubs are desired. The leaves are gathered several times during the year, the young leaves alone being plucked. The drying begins directly the leaves are gathered, and it is effected partly by the sun, and partly by charcoal fires. During the drying, the leaves are rubbed between the hands, so as to roll them up; and, when over the fire, are constantly stirred to prevent their scorching. When quite dry, they are either retained for use or sent to one of the sea-port towns, where they are again dried, packed in chests lined with thin sheet-lead, and shipped for this and other countries.

There are two kinds of tea brought to this country, black and green: it is not ascertained whether these are produced by the same or different plants. The green tea appears to differ from the black chiefly in the leaves being gathered without the stalks, which are always present in the latter, and in being less heated in the drying. It is an error to suppose that its green colour is owing to its being dried on copper pans.

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228. What is tea, whence and how procured?
229. What of the varieties, and consumption of tea?

The mode in which tea is used as an almost universal article of diet in this country and England is well known; and when taken in moderate quantities it is not injurious, as it cheers the spirits and refreshes the body; but, in large quantities, tea, or any other liquid, is unwholesome, by weakening the tone of the stomach, and preventing the due digestion of food. [It has been ascertained that 8 millions of pounds are used in this country, and 30 millions in England annually. In the latter country the black tea is most generally used, but in America the green is preferred.]

Vinegar.—Vinegar is an acid liquor much used in flavouring food, and for pickling. It is readily obtained by allowing any liquid containing a small quantity of spirit to be exposed to the air, when a kind of fermentation goes on, by which the spirit is changed into the sour or acid principle of the vinegar. Formerly, vinegar was made by exposing weak wine, or a kind of malt liquor brewed without hops, for a long period to the air in open vats; but now the process is much more rapidly conducted, by allowing the liquor to flow through loose shavings, by which it is so much more exposed to the air, that it is changed into vinegar in less than two days. As thus obtained, vinegar is a reddish-brown coloured liquid, of an agreeable, aromatic, but rather pungent odour, and a sour taste. It has been used as a condiment from the earliest times; and, in the sultry eastern countries, its cooling and acid properties cause it to be much valued. From its being so readily procured by allowing any weak spirituous liquor to become sour, it was generally employed, being used by the labourers in harvest time. (Ruth ii. 14.) Its well-known effect on the teeth, when undiluted with water, supplies Solomon with an apt comparison. (Prov. x. 26.)

Vinegar, or sour wine, was the usual drink of the Roman soldiers; and, mingled with myrrh, or some such bitter substance, it was offered to the Messiah when on

230. What is the nature and uses of vinegar?
231. How may it be procured?
232. What scriptural references are cited?

the cross. By St. Matthew (xxvii. 34 and 48) the offered beverage is termed vinegar; by St. Mark, wine.

At the present time, in England and this country, vinegar is used for seasoning food, for preserving vegetable substances from decay, and for forming pickles. In large quantities, however, it has a very injurious effect, weakening so much the structure of the stomach as to prevent the food being digested.

Vinegar of a much stronger kind is now obtained, in large quantity, by heating wood to redness in iron vessels, when a sour liquor passes off in vapour, which, when purified, is found to contain the same acid as vinegar; this is much used in making pickles.

Wafers.—The wafers in common use for fastening letters are made with wheat flour. This is first stirred up with water so as to make a thin fluid, quite free from any lumps or unmixed portions of flour. Then, according to the colour required, various substances are mixed with it; such as vermillion, indigo, gamboge, lamp-black, &c. &c. The worker then takes a tool formed of two thin iron plates, which he can bring together like a pair of tongs or pincers, but which do not quite touch, leaving a small space between them as thick as the wafers are to be; he first slightly warms the plates, then gives them a thin coat of grease, when they are filled with the flour paste, closed together, and held over a charcoal fire. On being opened when cold, a thin cake of wafer is found nearly dry, brittle, and about as thick as an address card; this is by means of ring-shaped punches cut into small round pieces of the size required. The use of wafers depends upon their becoming, when moistened, both soft and adhesive; if in this state they are placed between two pieces of paper, and the latter pressed together, the wafer adheres to both, and, when dry, firmly unites them.

The substances used for colouring wafers are frequently poisonous. This is especially the case with red ones,

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233. Name the various uses of vinegar.
234. How are wafers made and coloured?

which are tinted with either red lead or vermillion, both unwholesome substances, and very injurious effects have resulted from their being moistened in the mouth when used in large numbers, in which case they should be dipped in a cup of water.

Coarse wafers, made with red lead and flour, are used for poisoning black beetles or cockroaches.

WALNUTS.—These nuts are the fruit of the walnut tree, which is not a native of England, but of the warmer parts of Europe and Asia; and in the colder parts of Britain it will not ripen its fruit. [It grows abundantly in America.]

The tree, which produces timber of a very valuable kind for use, as gun-stocks, &c., is of a beautiful appearance, bearing leaves which are divided into seven or nine divisions or leaflets, and two kinds of flowers, the barren blossoms being in long heads or catkins, which soon fall from the tree, whilst the fertile ones grow only two or three together, and are each succeeded by a large oval fleshy fruit, which consists of an outside green coating having a very bitter taste, and which possesses the property of dyeing the skin a dingy greenish yellow colour, which cannot be removed without much trouble; this green rind covers a hard oval shell, which consists of two pieces, each of which is deeply and irregularly grooved; this shell contains the seed or kernel, which is a very irregularly shaped body, covered by a brown skin.

The fruit of the walnut tree is useful for a variety of purposes; before the inner shell has become hard, the whole fruit is pickled, and the juice obtained by crushing them in this state forms walnut ketchup. When ripe, the outer rind has been used as a dye for staining wool, hair, &c., of a greenish yellow colour.

The kernel forms a delicious and nutritious article of food; it contains a very large quantity of oil, even as much as half its weight. This oil is extracted by pressure, and is of considerable value to painters and varnishers, from the

235. What is said of their poisonous qualities?
236. Describe the walnut tree and its fruit.
237. To what uses are the fruit and wood applied?

property it possesses of drying very quickly; and in some countries it is used for food, in the same manner as salad or olive oil.

WILLOW or OSIER.—In this and other temperate countries grow a large number of trees known by the names of willows, osiers, or sallows. They are found in damp and watery situations, some attaining the size of large trees, whilst others are small plants; both kinds bearing long straight twigs.

The great value of the willow and osier depends on the long straight shoots they put forth, which are very flexible, exceedingly tough, and of very rapid growth. These circumstances have caused them to be selected for the purpose of making baskets, hampers, crates, &c. When employed for large baskets, the largest shoots are taken, and the bark is not removed; for smaller baskets the bark is stripped off; and for still finer work the shoots are split into small strips, which are worked up into hats, and even bonnets, fine baskets, &c., &c.; they are previously bleached by being held over burning sulphur. Besides its use for basket-work, the toughness of the willow leads the cooper to use it for the hoops of casks; for which purpose the larger shoots are split down the centre, and the ends being fastened together form hoops, the flat split side fitting closely to the cask.

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238. What of the willow or osier?
239. What is its value and uses in the arts?

OBJECTS

DERIVED FROM

THE ANIMAL KINGDOM.

SHELLS.

INTRODUCTION.—Shells are the hard substances that cover, and at the same time protect, the bodies of the animals that inhabit them. These animals are soft, fleshy, and cold to the touch; they differ from the higher animals in not possessing an internal framework, or skeleton, and in having cold and white blood; also in the absence of a brain, and in their senses being usually less developed.

The shells themselves consist of chalk, or carbonate of lime, mixed with animal matter; they are formed from the skin of the animal they enclose; when the latter is small, the shell is small also; and as the animal grows, it enlarges the shell, by adding to it at the edge of the opening.

As the shell is thus formed upon the animal, its shape, of course, depends entirely on that of its inmate.

The various colours that adorn shells are deposited from glands in the skin of the animal, when the substance of the shell is still soft.

Besides this power of constructing their habitations, they have the power also of repairing them when any breach has been made in them.

Shells are interesting to us, not only on account of the

241. What are shells, and of what composed?
240. What of their shape and colour?

use of the animals as food, but from their beauty, and the wisdom displayed in their structure; for we find each shell suited to the position in which it is placed: some, by their impenetrable hardness, are well adapted to the rapid rivers in which they are found; others, which are fragile, are, by their very lightness, preserved from being thrown with force against any substance, and they float on the surface of the sea uninjured.

To the natives of savage countries, shells are especially valuable; of broken pieces they make substitutes for knives; they also use them to form their arrow and spear-heads, and even their fish-hooks; they are also used as vessels for holding liquids.

In many parts of America, lime is obtained in large quantity from shells, the animal part of which has been destroyed by burning.

Shells have been arranged in three great divisions or classes; those which are formed of one piece, or valve, are called univalve, as the snail, whelk, &c.; those formed of two pieces, joined together by a hinge, are called bivalves, as the oyster, mussel, &c.; and those formed of several pieces, are called multivalves, the most familiar instance is the barnacle.

Shells of One Piece, or Univalve Shells.—The principal parts of a univalve shell are the *whorls;* they are the parts that roll round and form the *spire*, the largest one being called the *body whorl;* the *mouth*, which is the entrance into the shell; the *lips*, which form the edge of the mouth; the *base*, which is the largest part of the shell; and the *point* or *top*. Some shells have a projection at the bottom of the mouth: this is called a *beak;* the inside of the beak is a *canal*, in which the trunk of the animal fits. The animals inhabiting such shells have a head distinct from the body, and generally furnished

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242. For what are they interesting?
243. Of what use are shells to savages?
244. What classification has been made?
245. Describe the univalve shells.

with long organs, termed feelers; they have also eyes, and a fleshy foot, on which they crawl.

Snail Shell.—This shell is a univalve of a conical form, with a large swelling body whorl, a smooth surface, and round mouth. Its inhabitant is one of the pulpy animals distinguished by crawling on a broad fleshy foot, which is placed on the under part of the body; it has a distinct head, with mouth, &c., and four feelers, the two upper and longer of which, carry at their ends the eyes, which appear like black spots. The food of the snail is entirely vegetable; during winter they become torpid, and close the mouth or opening of the shell with a thin lid, which they have the power of forming. In dry weather, even in the greatest warmth of summer, they will close up the shell as described. Also, if they are put into a box without food, they will attach themselves to the side, and become torpid, in which state they will remain for years, and will immediately revive if moistened with water. The writer cannot call to mind a more beautiful instance than this of the infinite wisdom and goodness of the great Creator: not only are these animals able to abstain from food during winter, but when occasional dry weather has parched up the vegetables on which they subsist, they have the power of becoming dormant; whilst the same refreshing shower that restores the green herbs, brings back again to life those beings whose food they form. As the snail is not exposed to the violence of the waves, it does not require a strong shell like that of the periwinkle; it is therefore provided with a thin light one, that does not encumber its movements; and it is an acknowledged fact that no art could form a substance, affording the protection it does, of so light a weight. Various kinds of snails have been employed as food; a very large kind was anciently fatted for the table by the Romans, and is now eaten by the Roman Catholic inhabitants of many parts of Europe during Lent; this kind has been introduced in England, and is now very common in the chalk hills of Surrey and other parts. The common garden snail has been employed as food in consumptive cases, as it is extremely nutritious and easy of digestion.

From the power that snails possess of becoming torpid during drought, they are enabled to inhabit the most desert plains; and on the small tufts of coarse grass and herbage found there, large snails are abundant, and it has been thought that they formed part of the food of the Israelites, during their passage from Egypt, as large ones are abundant, and to the present day are eaten as a delicacy in Egypt. Snails form the favourite food of birds of the thrush kind, whether in a wild or confined state.

Shells of Two Pieces, or Bivalves.—The two pieces or valves of which these shells are formed are united, at the part called the hinge, by an elastic ligament, the effect of which is to keep the shell open; but the animal, by means of strong muscles which pass from its body, and are attached inside to the valves, can close them at pleasure. It is these muscles that are cut away when the oyster is taken from its shell. At the hinge are often small prominences called teeth, and the points of the valves over the hinge are called beaks. The animals inhabiting these shells differ much from those of the univalves. They have no distinct head; consequently, no eyes, nor feelers; and their mouth is merely a small aperture or hole. Some of them have a foot, by which they can creep slowly from place to place. Others, as the oyster, cement themselves to the rocks, and are incapable of motion. The food of these animals is found in the water in which they all live, and is washed into their shells, when they allow the elastic ligament to keep it open for that purpose.

Mussel.—The shell of the mussel consists of two pieces, of equal size, and of a similar shape, which is oval, and pointed at the beaks. The colour is dark brown; the inside is pearly white, blueish towards the edges. The animal has the power of fixing itself to one spot, or of moving from place to place, by means of a tongue-shaped

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246. What of the snail?
247. What wonderful power in the snail is named?
248. What is said of snails as food?
249. Describe the bivalve shells.

foot, which it can push out of the shell to some distance, and draw in again. When they wish to move, they place the shell erect on its edge, and stretch out the foot. This, being sticky, adheres to the ground, and, when shortened, pulls the shell along. In this way, the mussel moves until it finds a convenient place of residence, when it forms a bundle of fine silky threads—one end of which it fastens to the rock, and the other is attached to the animal; and thus it remains securely anchored. Mussels are found on our coasts in immense numbers, collected in beds, which are uncovered at low water. Women and children tear them away from the rocks and stones to which they are attached, by an iron hook. In England, they are sold as they are thus collected; but in France they are fattened as we fatten oysters. The mussel, which is usually eaten boiled or pickled, is rich, and not unwholesome when it is in season. In the spring time, however, it is to many persons injurious; as it is then liable to be diseased. This noxious quality was long thought to be owing to a small crab which often takes up its abode in the mussel-shell; but there seems to be no reason for believing this to be the case. The mussel is much used by fishermen as bait for catching both cod and haddock.

Oyster.—The shell of the oyster consists of two pieces, which are roundish, but very irregular in form, and are not alike; one being nearly flat, the other convex or bulging. The outside is very rough and scaly, and of a dingy colour. Oysters are found in the sea, with the lower or convex shell fixed firmly or cemented to rocks or stones, or to one another. They prefer a rough and rocky bottom, to which the shells can adhere firmly, better than a sandy one; and they are generally found in water varying from five to twenty fathoms in depth. They are fished up with a dredge, which is a kind of net with an iron scraper at the mouth—the use of which is to separate the oysters from the rocks. After being taken, they are placed, for six or eight weeks, in ponds of sea-water to fatten. Oysters

250. Describe the mussel and its shell.
251. What of the oyster and its shell?

abound on the shores of Great Britain and America. The fishing for them gives employment to 100,000 people. Oysters form a light food, easy of digestion.

Mother of Pearl.—This is the hard, silvery, brilliant substance which forms the internal layer of several kinds of shells. The interior of our common oyster shells is of this nature; but the mother of pearl used in the arts is much more variegated with a play of colours. The large shells of the Indian seas alone have this pearly substance of sufficient thickness to be of use. The play of colours seen in mother of pearl depends on its peculiar structure. It has, even when polished, an immense number of small furrows running across the surface. These reflect the light in such a manner as to produce the various hues seen on the surface. These furrows, though too small to be perceived by the naked eye, may be easily seen with a microscope; and impressions of them may even be taken in very fine black sealing-wax, which will then possess, to a considerable extent, the same changing coloured appearance. Mother of pearl is used in the arts for forming small articles; as counters, handles to knives, and salt-spoons, &c., &c. It is also much used for inlaying dark woods, with which its beautiful and varied surface forms a striking contrast.

INSECTS.

Introduction.—Insects are a large and very numerous class of animals, distinguished by their form, which in general has the appearance of being cut into three parts;

252. What of fishing for them, and their abundance?
253. Whence is mother of pearl derived?
254. What are its various uses?

the head, trunk and abdomen. They are also distinguished by passing through several changes before they arrive at the perfect state.

The bodies of insects are not (like those of the higher animals) supported by an internal framework of bones, but by the hardened and in most cases horny skin which gives shape to the body, and forms also the joints of the limbs.

The head of insects is covered with several distinct pieces of hardened skin. It usually supports two organs, or parts, which from their use are termed *feelers;* below these is the mouth, the direction of which is perpendicular. On the head also are placed the eyes, which are sometimes simple in their nature, sometimes very compound, each apparently simple eye consisting of a large number of eyes united together.

The trunk of insects supports the wings, of which there are usually two, as in the house-fly, or four, as in the butterfly. Sometimes the two upper wings are not used for flight, but are hardened into a horny covering for the protection of the two lower, which are then very thin and delicate; this is the case in the ladybird, cockchaffer, beetles, &c. From the trunk also spring the legs, which in all true insects are six in number.

The breathing of insects is not carried on by lungs, nor does the breath pass through the mouth, but enters into the body by several holes or pores on the sides.

The changes through which insects, properly so called, pass, are very singular. The animal when in the perfect state lays eggs usually in great numbers, which are of very various shapes, and covered with a skin, although destitute of a shell. The warmth of the climate hatches these eggs into *larvæ*, or, as they are more frequently termed, *grubs*, *caterpillars*, or *maggots*. These larvæ are at first very small, but they usually eat voraciously, and grow with great rapidity. A silkworm, for instance, in thirty days weighs many thousand times its orginal weight.

255. How are insects distinguished?
256. Describe their peculiarities.
257. What of their breathing, and of their eggs?
258. What are they when hatched?

During their continuance in the larva state, the growth is too great for the skin to enlarge sufficiently to contain the body of the animal; it is therefore changed several times. Arrived at its full size, the larva changes into a chrysalis, or *pupa;* in which state it is incased in a horny covering, is destitute of limbs and of the power of motion.

After a time, however, the animal bursts forth from this tomb, and appears as the perfect insect. Its life in this state is usually but short; it lays its eggs for the production of another generation, and dies.

In some insects the whole of these changes are not distinctly marked, the grub and perfect animal being very much alike; this is the case in the cockroach, &c.

Though small, insects are of vast importance in the world; many yield a number of useful products; whilst others remove with rapidity the decaying remains of animal and vegetable substances.

Bees.—Bees are the well-known insects that are domesticated, and kept in hives by man, for the purpose of yielding honey and wax. In their natural state they live in large societies, forming their habitation in the hollow of a tree or rock. (Deut. xxxii. 13; Ps. lxxxi. 16.) This is still the case in some parts of America; but in Europe they are seldom seen in a wild state.

Like most other insects, the bee is divided into three parts,—namely, the head, the chest or thorax, and the abdomen. The head, which is fastened to the chest by a thin neck, supports the feelers, the eyes, the mouth, and the various parts connected with it. The chest has the six legs and the four membranous wings attached to it; whilst the third part, or abdomen, consists of several rings, the last of which carries the sting.

In every hive there are three kinds of bees—the drones, the workers, and the queen.

The drones are easily distinguished by their nearly

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259. What changes are specified?
260. Of what use are they?
261. What of bees, and their structure?
262. How many kinds of bees in a hive?

cylindrical form—the abdomen not tapering towards the tail; by their large eyes, which meet at the top of their head; their chest being thickly covered with short pale brown hair, resembling velvet, and the wings being large and rather longer than the body, and they are destitute of a sting. In each hive there are usually from 700 to 2000 drones.

The working bee is smaller than the drone, from which it is readily known by the abdomen tapering towards the tail, and by its wings not reaching quite to the end of the body. It is also armed with a straight sting. In a well-stocked hive there are from 15,000 to 20,000 working bees.

These bees are occupied in collecting honey, pollen or bee-bread, a sort of varnish called propolis, in forming wax, building the combs, and attending to the young.

The honey is collected from flowers by means of the tongue, which is like a flat strap, and is used in lapping up the honey. This is swallowed by the bee, and is carried to the hive, where it is disgorged; part being used in feeding the young, and the rest stored up in the cells of the hive for winter consumption.

Pollen, or bee-bread, is a fine yellow dust collected by the bees from flowers; this is carried on the hind leg, the middle joint of which is made broad and furnished with a rim of strong hairs, so as to form a sort of basket, admirably adapted for the purpose to which it is applied. This pollen, or bee-bread, mixed with honey, forms the food of the young bees; for which use alone it is collected.

The substance termed propolis is a sort of resinous varnish, collected by the bees from the buds of trees; its use is to stop any holes in the hive, and to form some parts of the comb.

The queen bee is distinguished from the working bees by the great length of her abdomen, which is in the form of a lengthened cone; by the shortness of her wings,

263. Describe the drones and their number.
264. What of the working bees, and how many?
265. What variety of their products is named?
266. What of the queen bee?

which do not reach more than half the length of her body; and she differs from the drones in being furnished with a sting.

In each hive there is but one queen, who is treated with the greatest respect by the other bees. It may be wondered, perhaps, how they can distinguish the queen in the dark hive; this, however, they do by the feelers.

If the queen is accidentally lost or destroyed, her absence is soon discovered by the workers, and the greatest confusion and disorder follows. They immediately proceed to supply her loss, by rearing up some of the young grubs with rich food, so that when hatched they are queens. The strongest of these young queens then kills the others, and retains possession of the hive.

If the queen be removed from the hive, and a strange queen immediately placed in her stead, the workers surround her and keep her prisoner till she dies of hunger. But if the strange queen be not introduced for twenty-four hours, she is treated very differently, being at once admitted to the sovereignty of the hive.

Should a strange queen be placed in a hive whilst the right queen is there, the two fight; one is killed by the stings of the other, who remains mistress of the hive.

The only occupation of the queen is to lay eggs in the cells prepared in the comb by the workers for that purpose; she takes no care of the young herself. The number of eggs laid by the queen is very great, sometimes as many as forty or fifty a day; one being laid in each cell. The egg is one-twelfth of an inch long, and of a cylindrical form, with rounded ends. In three or four days it is hatched, and becomes a grub or larva; this is immediately fed by the workers, with food consisting of honey and bee-bread mixed together. After five or six days the grub is full grown; it then spins for itself a silken lining to its cell, and turns into a pupa, or chrysalis, and in about eight days changes into a perfect insect.

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267. What of the death of the queen, and her substitute?
268. How is the queen employed?
269. What of the hatching of the eggs?
270. How is the succession of queens secured?

The eggs that are intended to become queens are deposited in larger cells, and the grubs fed with more nutricious food. Shortly before the young queens are hatched, the old one becomes restless, and at last quits the hive with a great number of the bees, to seek a new home; and it is thus that the first swarm occurs. The next swarms are led off by the young queens, as they are hatched in succession; until at last the number of bees left is not large enough to furnish any fresh swarms; then the strongest of the young queens kills all the others, and remains mistress of the hive.

The usual number of swarms is two or three; in a very populous hive sometimes as many as five swarms are sent off; but this is rare.

Each swarm, as it quits the hive, usually clusters on some bush or tree in the neighbourhood; and if it be not hived, will take possession of a hollow tree, or some other convenient place. As soon as the swarm is accommodated with an empty hive, they proceed about building a comb. The first step to this is the formation of the wax. This substance is not, as was long supposed, collected by the bees from flowers, but is formed by them. During the operation they hang themselves in festoons from the top of the empty hive, and remain thus clinging to one another for some time. Whilst thus suspended the wax is formed in little scales, eight in number, which appear between the rings of the abdomen. After the wax is formed, the bees commence building the first comb, by placing the wax against the top of the hive. As fast as the wax is placed by one set of bees, another set commence hollowing it out into cells on each side, the wax that is dug out of the hollows being added to the edges of the cells to deepen them. As soon as the first comb is so far advanced as to contain two or three rows of cells, another comb is commenced on each side of it, about half an inch apart, so as to leave room for the passing of the bees. All the combs are begun at the roof of the hive, and built downwards. The hive, when full, consists of a number of these combs

271. What of swarming, and their industry?

hanging perpendicularly from the roof, and about half an inch apart, with cells on both sides.

The cells are six-sided, and it has been proved by mathematical calculation that no other shape could be adopted without a waste of wax.

The cells in the comb serve for various purposes: some are for the queen to deposit the eggs in, where they are hatched into grubs, and finally into young bees. In another set of cells bee-bread is stored up, and some contain honey for winter use. The latter are joined to the sides of the hive, as the weight would break them down if they only hung from the top.

The bees never consume the honey that has been stored up, except in seasons of scarcity, as in winter; each cell, as it is filled with honey, being sealed up with a wax covering.

Bees'-wax.—Bees'-wax, the formation of which has already been described under the article "Bees," is prepared for use by washing and melting the comb, the honey having been previously extracted; in this state it is yellow, and has a peculiar smell. As it is much used in this country and England, large quantities are brought from Africa, Cuba, and Russia. Yellow wax is freed from the impurities mixed with it by melting, when the heavier particles sink to the bottom, and the lighter rise to the top, and are removed by skimming. In this state it is cast in the form of cakes, and is used for making ointments, cements, &c.; it melts quickly under the heat of boiling water, and becomes soft at the temperature of the human body. If it is worked about in the warm hand, it quickly becomes sufficiently soft to take the impression of any object it is pressed upon, and it retains the form when cold and hard; in this manner wax is much used by dentists, &c. to take copies of small objects. But the great consumption of yellow wax is in the formation of white wax. This is accomplished by the process of bleaching; the

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272. What of the cells, and their variety?
273. What is bees'-wax?

yellow wax is first melted and freed from its impurities, and then formed into thin ribands or shavings, by pouring it into water. These ribands of wax are then laid upon canvas stretched between poles in the bleaching ground, where by the action of the sun upon them they finally become colourless, and are cast into small flat cakes and sold as white wax. In this state it is used for making artificial flowers and fruit, for waxing sewing thread, &c., but chiefly for making wax candles. The manufacture of wax candles differs from the mode adopted in making any other kind. Common candles are made by dipping the wicks into the melted tallow a sufficient number of times to render them fit for use: the name of dips is given them from the manner in which they are made. The candles called moulds are made by pouring the melted tallow into pewter moulds in which the wick is stretched; when cold the wick is pulled, and the candle comes readily out of the mould. But if wax were to be treated in the same way, it would not come out readily from the mould: therefore another mode is pursued in forming candles of this substance. The wicks are hung to a hoop suspended from the ceiling over a pan of melted wax; the workman pours over each wick a quantity of wax; this adheres to the wick; but as the candle will be larger at the bottom from the running down of the melted wax, it is unhooked and hung up again bottom upwards, when wax is again poured over it, and it becomes of a more uniform cylindrical shape. It is then taken from the hoop, laid on a moist slab, and rolled with smooth boards until it is of the proper shape; and the required length is given it by cutting off the rough end. The wicks that are used for candles are made of loosely spun cotton. The use of candles for lighting is well known. When the wick is lighted, a part of the wax or tallow is melted; this portion is drawn up by the wick into the flame, and there burns. In order to get the greatest amount of light from a candle, it should be snuffed frequently, as it then gives out much more light, and does not burn away faster. If the wick is long the flame is dull; that part of the tallow that would give out the most light, instead of burning, settles on the wick

in large clots. It has been found by experiment that a candle immediately after snuffing gives the greatest amount of light, in twelve minutes time only one-third as much, in nineteen minutes less than a quarter, and in half an hour not one-sixth as much as at first.

Black Beetle or Cockroach.—This annoying insect, now so very common in many houses, and almost always found in bakehouses, corn-mills, and on board ships, was not originally a native of England, but was brought there either from Asia or from America. When full grown it is about one inch long, of a dark brown colour, and nauseous disagreeable smell. The head, which is partly hidden by the chest, is furnished with two long thread-like feelers, each formed of a large number of minute joints. The male is readily distinguished from the female by its wings, which are covered by the wing cases, and extend half the length of the body. The female has only the rudiments of wings, and is much broader than the male. The eggs are usually sixteen in number, and are contained in an oblong case, which is at first white, but afterwards becomes brown and hard. Whilst this case is soft, the female carries it about with her, being attached to the extremity of the body; afterwards she fixes it to various substances by means of a gummy matter. When the young escape from the egg, they are not in the form of a grub, but appear very like the perfect insect, though they are destitute of wings. The cockroach does not, like the butterfly, undergo the complete set of insect transformations from egg to grub, then to chrysalis, and lastly to the perfect insect. Cockroaches are nocturnal animals, exceedingly active at night, but concealing themselves in crevices, &c. during the day. They run extremely fast, and are very tenacious of life. Their food consists of meal, bread, and various eatables, raw potatoes,

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274. How is the yellow colour changed to white?
275. Name the various uses of wax.
276. What of wax candles?
277. Describe the burning of a candle, and the effect of snuffing.
278. What of the cockroach and its peculiarities?

&c. They are extremely voracious, and when their usual food fails them, will devour almost any thing that comes in their way, as woollen and silk garments, and even the upper leather of shoes.

The injury they do in some parts of Russia and Finland, where they are very numerous, is extreme. On shipboard also they are very numerous and destructive. They may be destroyed by poisoned wafers, or by catching them in a box with a glass top like a tea-cup without a bottom, down which they slip and cannot ascend; they are then readily destroyed by being thrown into boiling water.

Silkworm Moth, and its product.—The silkworm, though now spread over a great part of Europe, and even of America, originally came from China.

The animal is erroneously termed a worm, as it is really a kind of caterpillar, and passes through all the changes which so strikingly distinguish insects from other animals.

The eggs from which the silkworm are hatched are about the size of mustard seeds. The caterpillar or silkworm is at first very small, and of a dark colour; it however rapidly increases in size, becoming cream-coloured, and feeding voraciously on the leaves of the mulberry, which form its natural food.

In about eight weeks the animal arrives at its full growth, having during this period changed its skin four or even five times; before shedding each skin the silkworm refrains from eating, remaining in a quiet state; it then bursts the old skin near the head, and works its way out.

When full grown, its length is from two and a half to three inches; it then commences forming the cocoon of silk, enclosed in which it lies as a chrysalis till it undergoes the change to a moth. The animal usually selects

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279. What is the nature and habits of this insect?
280. How may they be destroyed?
281. Describe the silkworm and its changes.

some corner in which to perform this operation, moving its head from side to side, and fixing the thread at different points, so as completely to enclose itself. As the worm is inside the cocoon, it follows that the outside portions of it are first formed, and the interior last. In about five days the animal ceases to spin, having during that time diminished very much in length; it then becomes torpid, changes its skin, and appears in the form of a chrysalis enclosed in a dark brown hard case. In this state it remains from a fortnight to three weeks, and then changes into the moth or perfect insect, which is enabled to escape by softening a portion of the cocoon with a fluid which it has the power of forming.

The whole cocoon spun by the silkworm is not equally valuable; the external part is flossy, weak, and comparatively useless. The first process in obtaining the raw silk from the cocoon is the destruction of the chrysalis; this is easily performed by placing it in an oven heated considerably. After the animals are killed, the rough outer floss is pulled off, and the cocoons are thrown into a vessel of hot water placed over a fire, in order to loosen the thread. The whole is then stirred with a bunch of twigs which catch the loose ends of the threads. Several of these taken together are wound off upon a reel; they are then tied up into hanks, which are ready for the use of the silk manufacturer, and are known by the name of raw silk.

In order to form a single pound of raw silk 2000 cocoons are necessary, the silk on each weighing about three and a half grains. Each cocoon is formed of one single unbroken thread, the length of which varies from 600 to 1000 feet.

The rearing of silkworms is not carried on to any extent in England, as the climate is too cold, and the mulberry trees too late in putting forth their leaves. Supplies of raw silk are chiefly obtained from the south of Europe and Asia.

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282. What of its cocoon?
283. Describe the process of obtaining raw silk.
284. What quantity is obtained from 2000 cocoons?

A number of the cocoons are preserved each year, the animals not being destroyed, but allowed to complete their change and come forth as moths. These are of a pale cream colour, and are covered with a fine down: they are furnished with short combs like feelers, and do not use their wings to fly, merely fanning the air with them. After a short time the eggs are laid; they are firmly cemented to the substance on which they are deposited, and are not hatched in temperate climates until the following year. The object of the moth's existence being then accomplished, it shortly dies.

It has been remarked, as an instance of the goodness of the Creator to man, that those animals most useful to him he has ordered should be the most easily managed; thus there is scarcely a caterpillar which could be reared by man with so small an amount of trouble as that which produces silk.

[The experiments made in this country in the silk culture have been recently revived, and are prosecuted with encouraging tokens of success. There can be little doubt that the causes of former failures are now understood, nor are there any insurmountable obstacles now in the way.]

Butterfly.—In England, the most common kinds of this insect are the large and small cabbage butterflies; both well known by the destructive effects of their caterpillars upon cabbage, brocoli, turnips, and other vegetables of the same kind. The caterpillar of the large cabbage butterfly is green, with three yellow lines running down the body, and is covered with black spots, each having a single hair growing out of the centre. The butterfly which is first seen in April, has two pair of wings, of which the foremost are white above, tipped with black, and slightly yellow beneath; the hinder being powdered with black.

The small white cabbage butterfly does not appear until about May; its caterpillars are bluish green, and are too often to be found in the very heart of cabbages, cauli-

285. What of the moths and their peculiarities?
286. What common varieties of butterfly are named?

flowers, &c. Were it not for the immense number of caterpillars destroyed by the various small birds, their ravages would be excessive. They also fall a prey to a small fly that lays its eggs in the body of the caterpillar; these hatch into grubs, which feed on the fat of the insect, and eventually destroy it before it changes into a chrysalis.

Like all true insects, these animals undergo several changes during life. They are hatched from small eggs (which are laid by the perfect insect or butterfly); these give birth to the caterpillar, an animal having a long body formed of twelve rings united together, and furnished on each side with nine breathing pores. The bodies of some kinds of caterpillar are covered with hairs, those of others are naked. Each caterpillar is further furnished with sixteen feet; of these, three pair near the head are horny; these afterwards become the six legs of the butterfly; the other five pair behind, being of no use to the perfect insect, are shed with the skin when the animal changes its state.

The head is small, and furnished with horny jaws which open sideways, and are well adapted for the devouring of their food. During the short life of the caterpillar it eats voraciously, grows very rapidly, and sheds its skin several times; when full grown it ceases to eat, fastens itself by a silken thread it has the power of forming to some object, and there changes into a chrysalis: in this state it remains some time, and then bursts forth as a perfect butterfly.

The cabbage caterpillar usually attaches itself to a wall to undergo this change, and its appearance when hanging in this situation by its silken thread must be familiar to most persons.

The life of the perfect insect is but short; it flutters about in the summer's sun, alighting upon the expanded flowers, and feeding upon their honey, which it sucks up by its spiral trunk, unrolling it for that purpose; it lays a large number of eggs, and almost immediately after dies.

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287. Describe the changes of these insects.
288. What is peculiar in the butterfly?

In consequence of the very great injury caused by these insects to the vegetables used as food by man, various means have been proposed for lessening their numbers, but the only effectual one seems to be the destruction of the caterpillars.

GRASSHOPPER.—Grasshoppers are well-known insects, remarkable for possessing, in an almost equal degree, the powers of flying and leaping. The body is thin, long, and flattened at the sides; the legs are six in number, the hinder ones being much larger than the others, and longer than the body. Each hind leg consists of three distinct parts—the thigh, the shank, and the foot; these legs are not used in walking, but are only employed in leaping. When the animal wishes to leap, it draws the feet of the hind legs close to that part of the thigh that joins the body; the joint uniting the thigh and shank being bent to a very sharp angle, high above the back of the insect; the various joints of the leg are then suddenly and powerfully strengthened, and the foot thus forcibly striking the ground, the animal is propelled high into the air.

The wings of the perfect insect are thin and membranous; when at rest they are not to be observed, as they are folded up in a fan-like form under the narrow wing cases.

The chirping noise made by the insect is caused by the rubbing of the thighs of the hind legs against the horny wing covers. The appetite of these insects is rather voracious; they feed entirely on vegetable substances, such as herbage of various kinds.

The eggs of the female are deposited in the ground, and the young hatched from them resemble the old ones in appearance; but they are not furnished with either wings or wing covers, consequently they are unable to fly or chirp. After some time these parts grow, and the young then become changed into the perfect insect.

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289. What of the grasshopper, and its structure?
290. Name its peculiarities.
291. What is said of young grasshoppers?

MISCELLANEOUS OBJECTS.

Bones.—Bones form the internal framework of the bodies of men, and of animals of the higher classes. In order to support the weight of the animal, bones must be firm, unyielding, tough, strong, and able to bear pressing, pulling, or twisting, without being liable to bend or break.

To combine all these properties, so as to fit them for their office, the all-wise Creator has formed them of two substances, one of which gives them toughness, the other firmness.

If we burn a bone in the fire, nothing is left but a brittle earthy substance, which before the bone was burnt gave it firmness and hardness; whilst the substance that was destroyed in the burning resembled glue, and its use was to produce toughness and tenacity, with a little elasticity.

If bones were all earth, they would be brittle, as is the case with the burnt bone. If they had no earth in them, they would bend like gristle, and could not support the weight of the body.

Bones are of several uses to animals. 1st. By their hardness and firmness they give support and shape to the body. 2d. They enclose and protect parts liable to be injured: thus the bones of the head protect the brain, and those of the chest the heart and lungs. 3d. The bones keep the limbs firm, and enable us to move them at the joints or the places where they are connected together; and in order that the ends of the bones may move more easily and smoothly, they are covered with a smooth gristle, and kept moist by an unctuous fluid.

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292. What of bones, and their requisites?
293. How is it that they combine toughness and firmness?
294. What are the several offices of the bones?

The long bones of the limbs are hollow, and are filled with an oily substance which hardens, when cold, into marrow. The advantage of the bones being hollow is, that they are lighter than if solid, and the same weight of bone is much stronger when hollow than it would be if formed into a solid body.

Bones are a very important article of commerce; the larger bones are used for various purposes; they surpass wood in hardness, and are not brittle. Tooth and nail brushes, knife handles, combs, paper knives, spoons, and a variety of small articles, are either turned or cut out of them.

The shavings and sawdust of bones formed in making these articles, are used under the names of ivory or bone dust for jelly.

If bones are heated in iron vessels they turn black, and in this state are termed bone black, or animal charcoal, which is much used in bleaching, and in clarifying sugar. (See SUGAR.)

But the great use of bones is as manure; for this purpose they are collected from every part of the country, and even from other countries, taken to the bone mills and crushed, sometimes coarsely, sometimes to a fine powder. In this state the farmer either scatters them over his land, or sets a quantity with his seed.

The earthy matter of bones contains a large portion of phosphorus; this is extracted from them by a chemical process, and used extensively for the manufacture of lucifer matches.

BRISTLES.—Bristles are the strong coarse hairs from the backs of swine. They are very much used for the purpose of making the best kind of brushes, brooms, &c. Shoemakers also use them instead of needles in sewing the soles of shoes and boots. The thin or split end of the bristle is twisted with the end of the thread, and the stiff end is easily passed through the hole made by the awl, and the thread pulled after it. Needles would not answer for

295. What of the hollow bones, and their contents?
296. Why are these bones hollow?
297. Name the various uses of dead bones.

this purpose, as the force required to push them through the leather would break them.

The bristles used in England are chiefly brought from Russia and Prussia, about 2,000,000 pounds being annually imported. Although the hog is entirely covered with bristles, yet those on the back only are of sufficient size and strength for use.

CORAL.—The various substances known to us by the name of coral, are the produce of certain animals inhabiting the ocean. Each of these animals has a cylindrical or oval body without a head; the body is hollow, and contains the stomach, which has but one opening, and this is surrounded by several feelers, arranged in a star-like manner around the mouth. The food of the coral animal consists of other small animals living in the water; when these latter approach within reach of the feelers of the former they are immediately seized, and forced through the mouth into the stomach.

These animals do not live alone, but in vast numbers together; growing like the separate buds of a tree upon a kind of stem, which is the substance we call coral. If a piece of white coral is examined, it will be found to be furnished with numerous holes, each of which was the habitation of a single animal. When undisturbed, the animal comes out of its cell, moving its star-like feelers in search of food; but when alarmed, contracting within the cavity. All these animals are joined together by a thin fleshy skin covering the coral. As the number of the animals increases, so does the coral branch out and grow, new cells being formed for the new animals. The coral is formed of lime chiefly, which the animals separate from the sea-water.

Immense masses of coral grow together, forming rocks or coral reefs, which rise up to the surface of the sea. Sometimes these are near the shore, coasting the main land for hundreds of miles, as in some parts of Australia.

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298. To what uses are bristles applied?
299. Describe the nature and structure of coral.
300. What of coral rocks, reefs, and islands?

In other parts, coral islands rise up to the surface of the sea, stopping at the top of the water; upon them sand and sea-weeds are drifted; the latter, by their decay, form mould, in which seeds brought by the currents of the ocean grow, until at last an island is formed fit for the habitation of man. Numbers of the islands in the southern seas have been produced in this manner. One circumstance is requisite to the inhabiting these islands by man; namely, that fresh water should be readily obtained; it is, however, an extraordinary fact, that if wells be dug in the coral islands they are found to be filled with fresh water.

It is not by the growth of one kind of coral that these reefs and islands are formed, but by that of several.

Many kinds are brought to this country, all of them being deprived of the animal forming them. The white coral has already been described; other kinds are yellow; but the most valuable is the red coral, prized from its colour, and great hardness, which enables it to receive a fine polish, and its freedom from pores or cells; its use for necklaces and other ornaments is well known. It is found in the Mediterranean Sea, in water of a moderate depth, and is obtained by divers.

When alive, the red coral is everywhere covered by a fleshy skin, upon which are placed animals like those before described; these when touched shrink back into the skin, but cannot penetrate the stem, as there are not holes for them.

Foot of Duck.—The foot of the duck is wonderfully formed to suit exactly the habits and wants of the bird to which it belongs. As the duck has to seek its food in water, it wants a foot capable of propelling it from one part of the stream to another; to answer this purpose we find that the foot is webbed—that is, a thin soft skin or web stretches from one toe to another, and unites them; when the duck, floating on the top of the water, wishes to swim forward, the webbed foot is pushed back against the water, and when the toes and web are spread out, the

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301. What are the varieties and uses of coral?

foot is large, and does not pass easily through the water; the body of the duck, which floats lightly on the top, is pushed on; the other foot is then used, and so on alternately as long as the bird wishes to swim forward. After each foot has been struck back against the water, it has to be brought forward before a second stroke can be made; if it were spread out when brought forward, as it is when pushed back, the body of the duck would be pulled back again. But this does not happen, for when bringing the foot forward to make a second stroke, the duck closes it; the toes, instead of being spread out, fall together, and are bent, so that they offer scarcely any surface to resist the water; from this account it will at once be perceived how admirably the duck's webbed foot fits it for a waterfowl. When the bird wishes to swim towards one side, it strikes the water with the foot of the opposite side several times in succession.

Though this foot is beautifully formed for swimming, it prevents the animal moving rapidly on land; and its broad boat-shaped body, that enables it to float so lightly on the water, also renders its progress on the ground waddling and unsteady; but its chief food is found in the water, and to that its formation is suited.

Feathers.—Feathers form the covering or clothing of the class of animals called birds. The importance of feathers to these animals will appear in the strongest light if we consider their habits. First, warmth is essential for birds; they are frequently exposed to great cold, as in the water, or when they ascend very high in the air, where temperature is always low. Again, the heat of their bodies is greater than that of other animals, and requires to be kept up by a warm clothing. It is also necessary that their covering should be exceedingly light; if it were heavy and dense, it is evident it would unfit them for flight. Of the lightness of a bird's covering we may form a good idea when we find that the plumage of a common owl (a bird abundantly clothed) only weighs one ounce and a

302. Describe the duck's foot, and its advantages.

half. This lightness must be combined with great strength, as the feathers of the wings are the parts with which they strike the air violently to impel them in their flight. Lastly, their whole covering must be so smooth as to offer the least possible resistance to the air in their rapid passage through it.

On attentive examination we shall find that these requisites, warmth, lightness, strength, and smoothness, are combined in the covering of birds in a manner that proclaims the wisdom of Him who has declared in his word that without Him not a sparrow falleth to the ground. Every feather consists of three parts—viz., the quill or barrel, the shaft and the vane or beard. The quill is that part of a feather by which it is attached to the skin; it is formed of a horny substance, which is of a hard and elastic nature, and is remarkable for being both strong and light. Lightness is given to the quill by its being formed in the shape of a hollow cylinder, which is filled with air; at the same time its strength is increased by this contrivance, for if the quill were formed of only the same weight of material solid, it would be considerably weaker. It is for this same reason that bones are hollow, that is, to ensure strength with the least possible degree of weight. That the quill may possess strength in all directions, it is formed of two sets of fibres (though, from their being transparent, this is not readily seen). One set runs the length of the quill; it is this set that we tear apart (not across) when we split up a pen; the other set runs round these, and binds them tight together: if we do not scrape off the circular set before making a pen, the slit is jagged, because we have torn these across violently. The membranous substance found within the quill is the dried remains of the pulp that originally nourished the feather.

The shaft of the feather is four-sided; it is largest near the quill, and gradually lessens in size to the end; it is slightly bent, to adapt it to the shape of the bird. It is covered with a horny substance like that of the quill, only

303. Name the importance of feathers to birds?
304. What four qualities do they combine?
305. What of the structure of each feather?

not so thick, and is filled with a light elastic substance called pith.

The vane or beard of the feather is composed of a number of flat barbs or pieces which grow from the sides of the shaft. They are placed with their flat sides towards each other, their edges being turned upwards and downwards; this method of placing them is the strongest that could be adopted, as it is their edges that strike the air when the bird is flying.

In looking at an unruffled feather, we may notice that the barbs or pieces of the vane are united together, and that they are not to be parted without some force. It is evident they do not adhere by any sticky matter, or the feather would feel clammy; and if we ruffle the barbs, and then smooth the feather from the quill to the end, they reunite. This reunion of the barbs after separation is effected by the following beautiful contrivance;—each barb has a set of tiny hooks springing from the top of each side; those from the side nearest the quill turn their points upwards, those on the other side hook downwards. When the feather is unruffled, these little hooks are all caught in one another, holding the barbs together; when the feather is ruffled by any force, they are torn apart, but not broken; for as soon as the sides of each barb are brought together by smoothing the feather, or by the bird's pruning itself with its bill, they reunite.

Perhaps some may suppose that the vane would have been better formed of one piece than of many barbs hooked together; but this is a mistake. Suppose the vane formed of one piece, and by any accident torn, it would not be in the bird's power to repair it; but if the barbs of the vane are ever so much ruffled, the bird has only to draw the feather a few times through its bill, and it again forms one firm flat body to resist the wind.

We often notice that the part of the vane nearest the quill is downy, and the barbs do not adhere together; this downy portion is next the skin of the bird, and serves to

306. How are the double sets of fibres seen in quills?
307. Describe the structure of the feathered end of quills?
308. In what does the advantage of this consist?

keep the body warm. From the top of the quill where it joins the shaft, a small tuft of down frequently arises; this is sometimes so large as to give the appearance of two feathers on one quill.

Feathers are often modified so as to suit the wants of the *particular* species of *bird*. Thus birds of prey, such as hawks and eagles, have hard, firm feathers, extremely strong and elastic. Owls have soft downy feathers, so that they fly silently at night, and surprise their prey. The ostrich and other similar birds, that do not fly, have the barbs not joined by hooks, but loose and flowing. Swimming birds have their feathers close and oily, to prevent the water getting to their skin, &c.

The coverings of birds are of great use to mankind, and form articles of commerce, under the names of quills, feathers, and down.

Quills are chiefly used for the manufacture of writing pens, and are obtained from wings of geese; large numbers are kept in the fenny parts of England, and are deprived of the quills and feathers several times a year. The quills when pulled from the animals are sorted according to their size and quality; the smallest are sold under the name of pinions. Before they are sold for use, quills are frequently stained yellow.

The quills of other large birds are sometimes used for pens, but they are not equal to those of geese. The quills of swans are collected in Russia for making pens.

Feathers are used in this country for stuffing beds, bolsters, and pillows.

The most valued are obtained from geese, the inferior kinds from barn-door fowls, ducks, &c.

Down is the warm under-clothing of many birds; the delicate and elastic filaments of which it consists are not hooked together like the barbs of feathers, but remain separate. Down is most abundant under the feathers of swimming birds, where it is requisite to prevent the water

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309. What of the down, and where found?
310. How are feathers modified in their structure?
311. Name the uses of quills and feathers.

abstracting the heat of their bodies; consequently it is much more abundant on the under surface of the body than elsewhere, as in many swimming birds that part is always in the water. The down of these birds is never wetted, as the close oily layer of feathers protects it from the water. The down of the swan is made into small tippets for the neck, &c., being preserved on the skin in the same manner as fur is. Some water birds, as the eider duck, pluck the down from their breasts to line their nests with; this is collected by the natives of the frozen regions, where the birds reside, and sold for a high price to stuff quilts, &c., for persons to sleep under in cold climates.

Fur.—Fur is the name given to the skins of animals in which the hair is very fine and close; these skins, after being removed from the flesh, are dried without the hair being scraped off, sometimes by the aid of alum water, and at others merely stretched out in the sun. The use of the covering of fur to the animal is to protect it against the changes of temperature. Fur is a very bad conductor of heat, or in other words, it does not allow the warmth of the body to pass through it, so that the heat natural to the animal is kept from escaping. That benevolent care which is found everywhere in the structure of animals, is not in any part more evident than in their covering. The fur of all animals is suited to their habits, to the climate they inhabit, and even to the season of the year. If we examine a hare or rabbit in summer, and again in winter, we shall find that at the latter season it is thicker and closer, much warmer, and therefore better suited to the cold of the season, than if only of its summer thickness. So well are the fur dealers aware of this fact that they only pursue the animals yielding fur in the winter; and even our own hare skins are worth much less in warm than in frosty weather. God's care of the animal does not consist in merely thickening the fur; in many instances he has so wisely ordered it, that with the approach of

312. What of the oily layer of feathers in swimming birds?
313. Whence is fur obtained, and how?

cold the fur changes colour, passing from the summer colour of the animal to white. This is the case with the hare in the north of Scotland, with the stoat in England, and with almost all the animals in the cold polar regions. At first sight this may seem any thing but a wise provision, for we all know that in summer dark clothes are warmer than light ones, as they absord more rapidly the warmth of the sun; but in extreme northern climates the sun has very little power in winter, and the light coloured fur of the animal prevents the escape of its own warmth much more completely than a dark coloured fur would do. Another advantage the animal gains by its change of colour is, that when the ground is covered with snow, the small quadrupeds are much less easily discovered by their numerous enemies, as hawks, owls, &c., and so more readily escape destruction. It should be borne in mind that the change of colour does not take place by the dark hairs falling out and being replaced by light ones, which would expose the animal to severe cold, but the fine hairs of the fur remaining on change colour. So rapidly will the fur become white, that it has been noticed that all the hairs on an animal have changed by a week's exposure to severe cold. Man, observing how completely animals are protected by their warm coverings, has long been accustomed to adapt them to his own use, more especially when he resides in cold climates. Many thousand animals are annually destroyed, their skins dried with the fur on, and then used for clothing. In cold climates the garments are frequently made or lined with fur; in this country they are only used in winter, and then partly for ornament. The principal furs used for this purpose are those of the hare, rabbit; the ermine, which is merely the skin of the stoat in its winter dress; various squirrels, sable, fitch, or polecat, &c. &c. The fur of the beaver, the hare, rabbit, and some other animals, is also used for the purpose of

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314. Of what use is fur to the animals, and why?
315. How does its thickness and colour vary by the season?
316. How does white fur serve the animal best in winter?
317. To what purposes are furs applied by man?

covering beaver hats and bonnets, being cut off the skin and fastened by varnish or glue upon the body of the hat.

GLUE.—Glue is an animal substance much used in the various arts as a strong cement. The best is obtained from the skins of animals, the small cuttings of which, rejected by the currier, being generally employed. An inferior glue is made from the sinews and hoofs of animals.

These materials are first well washed in lime water, which assists in removing any grease; they are then boiled in water until all the soluble parts are dissolved; the impurities that rise to the surface are skimmed off; the liquor is then strained to separate it from the undissolved pieces of skin, and lastly boiled down until it becomes on cooling a very firm hard jelly. This jelly is cut into thin flat square pieces, which are dried upon coarse netting; the depressions left by the network are always visible on the dried glue.

When of a good quality, glue is of a deep rich brown colour, semi-transparent, and without spots or clouds in its interior; and it should be perfectly soluble in water, not leaving any sediment. The solution of glue in water is, when cold, a jelly-like mass, which varies in firmness with the quantity of glue dissolved; even when made very firm it readily melts with heat, and it is in this state that glue is used as a cement. It is applied whilst hot to the substances which it is wished to unite; they are then pressed together, and as the glue becomes firm on cooling they remain cemented, although it is not till after some days (when the glue has become perfectly dry) that the joint is very firm.

The use of glue depends upon its being so readily soluble, especially in hot water, its adhesiveness when dissolved, and also upon its becoming solid as it cools and dries. Its tenacity when used as a cement is very great;

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318. Name some of the animals which furnish it.
319. What is glue, its use, and how made?
320. For what qualities is glue remarkable?

frequently the wood-work joined by it will break at some other place, and not at that at which it is cemented. Glue is useless in damp situations.

In order to prevent the glue from being burnt in heating, the carpenter employs a vessel called a glue-pot; this consists of two vessels, one placed within the other. The outer one, which is much the larger, is partly filled with water, whilst in the inner one the glue to be dissolved is placed. Its use is evident, for as long as any water remains in the outer vessel the glue cannot be burnt.

The workmen using glue are chiefly carpenters, joiners, and cabinet makers; a weak solution of it, resembling jelly in appearance, is much used by whitewashers in order to prevent the whiting from being readily rubbed off when dry.

Isinglass, so much used for making jellies for eating, is only a purer kind of glue obtained from the air-bladders or sounds of several kinds of fish. And a pure kind of glue is obtained from the skins of animals, and sold under the name of *gelatine* for the same purpose.

Hen's Foot.—The fowl belongs to that class of birds which in a natural state seek their food (which consists of insects, grubs, and seeds) in the ground; to enable them to do this, they are formed with exceedingly strong legs and feet, and toes furnished with stout, blunt, curved claws. The feet are used for scratching up the loose surface of the earth, the bird supporting itself on one leg, and scratching powerfully with the other. The claws grow very quickly, so that they are of a sufficient length to be serviceable to the animal.

As these birds have to seek their food on the ground, they do not greatly want the power of flying; the strong legs that serve them for scratching, give them the ability of running very fast, and of moving readily from one place to another in search of food.

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321. What are its varieties, and by whom employed?
322. What of the hen's foot, its structure, and uses?

HORN.—The substance known as horn is yielded by a large number of ruminating animals; as, for instance, by the ox, the goat, the sheep, and the antelope. The same term is often applied to the antlers of the stag or deer tribe; but very erroneously, as these latter consist not of horn but of solid bone, are generally branched, and are also shed annually, whilst true horns are permanent. The horns of the ox, &c., are of a conical form, and generally somewhat curved. They are formed of a bony core in the centre, which rises from the bone of the forehead; this is supplied with nerves and with the vessels which form the horny portion that surrounds it like a sheath.

Horn, like the nails of the fingers, is quite insensible—the tip may be cut off without giving pain; but if the bony core be injured, it bleeds freely, and the sufferings of the animal appear very great. The chief difference between horn and bone is, that the former is destitute of earthy matter; hence arises its semi-transparency.

The horns used in manufacture are obtained chiefly from the bull and the cow; so great is the demand for them in England that they are brought there in large numbers from Russia, the Cape of Good Hope, and South America.

Horn is prepared by first soaking it in water for five or six weeks; this loosens the core, and it can then easily be pulled out from the true horn. The solid part of the horn, near the tip, is then cut off, and preserved to be used in making knife-handles, buttons, &c.; the remainder is softened by boiling water, and exposure to the flame of a fire. In this state it is slit with a knife, and pressed flat between hot iron plates. If required for thin sheets for lanterns, it is pressed with great force, then split into thin layers, smoothed by scraping, and afterwards polished.

When prepared for combs, the horn is slightly pressed and cut into the required shape by a saw and rasps; the teeth are then cut by a saw, and finished by rasping.

If a very large piece of horn is required for a comb, or

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323. By what animals is horn yielded?
324. What of its structure, and peculiarities?
325. How is it prepared for use in the arts?
326. Name the various uses to which horn is applied?

any other article, two pieces are joined together by heating the edges until they are quite soft, and pressing them together firmly till they are cold.

Drinking cups are formed by moulding the hollow part of the horn (softened by heat) into a regular shape—it is then polished. A deep groove is afterwards cut or turned near the bottom; it is again softened by heat, and a flat piece of horn, of the proper size, forced into the groove. The cup contracts as it cools, and the joint is perfectly water-tight.

Horns were anciently used in making the musical instrument so called: the name still remains; thus we have the bugle-horn, &c.

Horse-Hair.—By this name is generally meant the hair of the tail and of the mane of a horse.

The long hair of the tail is woven into a kind of coarse cloth for sieves; also into a fabric for covering sofas, chairs, &c.; but in this case the horse-hair only runs in one direction, and threads of flax or hemp in the other, so strong and firm as to give great strength to the whole.

The long hairs are also used to form fishing-lines and violin-bows.

The inferior and shorter hair is used for stuffing mattrasses, sofas, &c. To fit it for this purpose, it is baked with a gentle heat, by which it is rendered much more elastic than before.

The short hair of the mane is used for stuffing horse collars, and for very inferior work.

Ivory.—Ivory is the name applied to the bony substance forming the teeth of various animals, as the hippopotamus, walrus, and elephant; though, usually, those of the latter alone are meant. It is the tusks of the elephant which furnish this substance—the grinding teeth are formed of various hard substances, not at all resembling ivory; these tusks usually weigh, each, from fifty to

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327. For what purposes is horse-hair useful?
328. Whence is ivory derived?

seventy pounds, and sometimes they are even much larger. When cut, the inner part of each tusk is found to be white, of a very fine, close grain; extremely hard, and yet elastic —slightly compressible by great force. When cut into thin sheets, it has a degree of transparency greater than paper of the same thickness. Its use in the arts depends on its possessing various properties. From its white colour and semi-transparency it is used in thin sheets to paint miniatures upon. The turner employs it for various small articles, on account of its beauty and hardness, whilst its elasticity and closeness of texture render it much less liable to crack than bone. Dentists use the various kinds of ivory for making artificial teeth: the qualities of hardness and whiteness again recommending it.

Ivory is composed of the same kind of material as bone (see BONE), viz., an earthy substance and glue; hence, the small fragments and powder formed in turning, filing, and working ivory, are sold under the name of ivory dust, for the purpose of making jelly; as, when boiled for some hours in water, the gluey portion dissolves and forms a nutritious jelly, fit for food.

LEATHERS, VARIOUS.—*Sole leather, upper leather, morocco leather, glove leather, and wash leather.*—Leather is a substance universally used amongst civilized, and very generally among barbarous, nations. It is made from the skins of animals, which are tanned and prepared with some substance having the power of changing the perishable skin, that decays readily when wet or moist, into a lasting and comparatively imperishable leather.

As leather is prepared from the skins of different animals, and is required for various uses, several tanning substances are used, according to the kind of leather required; that for the soles and upper leathers of men's shoes, for harness, and such like purposes, is prepared and tanned, as it is termed, with the aid of oak bark. The hides or skins, either fresh, as received from the butcher, or salted, as they are brought from abroad, being spread out, the

329. Name the various uses of ivory.
330. What variety of leather is named?

small pieces of flesh on the inside of the skin are removed; the hide is then soaked in lime-water, by which means the hair is loosened, and can be readily scraped off. Thus cleansed from the hair and flesh, it is soaked for some days in sour water, made so either by putting barley or rye flour into it, which remains till it becomes sour, or by adding a small quantity of oil of vitriol. This acid solution has the effect of opening the pores of the skin, so that the tan can afterwards penetrate into it more readily. The hide is then placed in the tan-pit along with oak bark and water; it is first placed in weak, and lastly in strong tan. Sometimes the hides and powdered bark are laid in layers one over the other until the pit is full. [Very great improvements have been introduced into America in the art of tanning leather, by employing heat in the tan-pits, and by reels upon which the hides are spread, and a rotary motion given by machinery to these reels, thus dispensing with the labour of handling, and manufacturing leather in less than half the time formerly required.] The process of completely changing the skin into leather is a very slow one. To make strong and well-tanned leather, the hides remain in the pits from six to twelve, or even to eighteen months. If the hides are taken out too soon, the middle of the skin is not tanned. The hides, being removed, are dried, and then passed between rollers, which gives them a smooth surface, and renders them firmer.

By these processes the skin is much altered in its properties; when it is taken from the animal it is soft and moist, but when it becomes dry it is brittle, and liable to crack, and very perishable, putrefying rapidly if kept wet: these qualities prevent untanned skins being of much use to man. Leather, on the contrary, is flexible and soft, whether it be wet or dry; it is, if properly prepared, water-proof and lasting, not decaying when moist; at the same time it is light and sufficiently strong to stand much wear when made into shoes, harness, &c.; for which pur-

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331. Of what is it made, and how?
332. By what agent is sole and upper shoe leather tanned?

pose these properties render it better fitted than any other material known.

The leather required for the upper leather of boots, &c. is sent from the tanner to the currier, who, by rubbing and paring it down, renders it more flexible, softer, and capable of being polished; at the same time he blackens it with lamp-black and oil, or tallow. The skins used for upper leathers are calf, and the thinner skins of cows and horses; whilst the thicker ones, of oxen, &c., are made into soles.

Other kinds of leather, required for different purposes, are made by slight variations in the process.

Morocco leather is prepared from goat skins, which are imported into this country. The flesh and hair are scraped off as before described; each skin is then sewed into the shape of a bag, which is filled with a vegetable substance termed sumach, and water; this, like the oak bark, is astringent, and it has the effect of tanning these thin skins in a few hours; they are then dyed of the colour required, and rubbed over with a grooved ball in order to give them the grooved appearance which distinguishes morocco leather. Imitation or inferior morocco is manufactured from sheep skins. As thus prepared, morocco leather is soft, and very flexible, from the rubbing it receives, whilst its grooved appearance renders it very beautiful. When dyed it is frequently chosen for covering books, for chair-covers, and lining carriages, &c.

The thin leather, which from its softness and capability of yielding or stretching, is usually selected for gloves and ladies' shoes, is tanned with alum, after the skin has been scraped free from flesh and hair. In order to render this kind of leather as soft and yielding as possible, it is, during the process, prepared with eggs and flour. Although the gloves and shoes made with it are termed kid, yet the skins used in the preparation are chiefly those of lambs.

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333. Describe the process in its several stages.
334. What improvements are used in America?
335. What of the currier?
336. Of what is morocco made?
337. By what agent, and how is morocco tanned?

The only other kind of leather to be mentioned is that termed wash, or shamois leather. In order to prepare it the skins are cleaned with lime, dried, and then beaten with heavy hammers, being kept wet with oil; they are then hung up to dry, again beaten with the addition of fresh oil; and this operation is many times repeated. The excess of oil is then removed by soaking the skin in water containing pearlash; it is afterwards dried, and is then fit for use. Being exceedingly soft, it is much employed in polishing metal articles; and, from its warmth and softness, it is frequently made into under waistcoats, &c. It does not resist the wet, and is, therefore, unfit for outer clothing.

Milk.—Milk is the fluid with which the young animals of the class of mammalia or quadrupeds are nourished.

It consists of several distinct substances, which separate from one another on its being allowed to remain undisturbed: these substances are cream, curd, and whey. The cream is obtained by allowing the milk to stand in shallow pans twelve or more hours, when it rises to the surface, and is readily removed. What remains is called skim, or skimmed milk; if this is allowed to stand some time it becomes sour, and the curd, or solid part, separates from the whey.

In this country the milk of cows is that most generally used for food; and, besides being most extensively employed in its fresh state, it is in great demand for making butter and cheese.

Butter is made by collecting a sufficient quantity of cream, which is placed in the churn, a wooden tub, wider at the bottom than at the top, and covered by a round lid with a hole in the centre, through which a handle passes, that is fixed to a round flat board with several holes in it. The cream, which fills two-thirds of the churn, is violently agitated, by the handle being moved up and down. [The churns very generally used in America are so constructed

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338. What other agents are used in making leather?
339. Define milk, and its several parts.

that the necessary agitation is given by turning a crank, which is done by steam in extensive butter manufactories.] In the course of an hour's churning, small lumps of butter appear, which soon unite together into larger masses. When the butter is formed, it is taken out of the churn, washed, and pressed, and (unless used fresh) is salted and casked for use. The liquid part of the cream left in the churn after the butter is removed is called butter-milk, and is chiefly used for feeding pigs, but is a nutritious and healthy drink.

Cheese is the curd of milk pressed and dried. The curd may be separated from the whey by allowing the milk to become sour; but the cheese so produced is inferior in quality. In this country rennet is added to the milk to curdle it; this rennet is a fluid prepared from the stomach of a sucking calf. The curd formed by the rennet is separated from the whey, salted, and strongly pressed into a shape; it is then dried, and is ready for use. The richness of cheese depends on the milk from which it is made. Skim milk makes poor hard cheese; whereas, if an extra portion of cream be added to the milk, as is done in making superior cheese, the quality is much improved. It is often the practice to colour cheese; this is done by adding a dye called annatto to the milk.

Although in England the use of cows' milk is general, in other countries that of different animals is used; as, goats' milk in Switzerland, reindeers' in Lapland, camels' in Arabia, and mares' in Tartary.

The milk of the ewe contains a much larger quantity of cream, and is richer than that of any other animal that has been examined.

That of the ass contains no cream, and is therefore drank by invalids, with whom oily substances would disagree.

PARCHMENT.—Parchment is a writing material made of the skin of sheep or goats. The skins are first prepared

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340. How is butter made?
341. Describe the process of cheese-making.
342. What other animals yield milk besides cows?
343. In what countries are they substituted?

by the leather-dresser, in the same manner as if they were to be formed into leather (see LEATHER), being soaked in lime to remove grease and loosen the wool, which is afterwards scraped off. They are then very tightly stretched, either over a hoop or by means of a strong wooden frame; then, with a large double-handled knife, the skin is scraped, or pared down on both sides, and all irregularities of the surface are removed, when it is ground, or rubbed smooth with pumice stone and chalk, or lime; it is then allowed to dry slowly, and is again scraped and ground with smooth pumice stone until it is reduced to the requisite degree of smoothness.

As thus prepared, the chief use of parchment is for writing upon, it being much stronger and less liable to injury than paper, and being less perishable. For this reason all legal writings, such as wills, leases of houses and land, are written upon it.

It is also used for drum heads, for binding books, &c.; but in these cases a stronger substance is required, and the skins of asses, calves, &c. are employed instead of those of sheep.

SOAP.—This useful substance is of great antiquity. In excavating the city of Pompeii, which was buried by an eruption of Mount Vesuvius, about 1700 years ago, a soap-maker's shop, containing soap, was discovered. In the Old Testament it is referred to in Jer. ii. 22, and Mal. iii. 2; but it is thought that what is there alluded to is the ashes of some plant.

The whole of the various hard soaps used by us are prepared from different kinds of fat, or oil, and the alkali soda (see SODA). It is necessary, in order to prepare soaps, that the common soda should be rendered much more caustic than it is in its usual condition; this is done by boiling it with lime fresh burnt, which, acting chemi-

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344. Whence is parchment derived, and how made?
345. Name its uses and advantages.
346. What is said of the antiquity of soap-making?
347. How are hard soaps made?

cally on the soda, greatly increases its caustic powers. The soda thus prepared and dissolved in water, forms what is termed the lye or ley of the soap-boiler. The soap called mottled is manufactured in the following manner. In a large iron vessel, heated either by steam or a fire, is a large quantity of melted tallow and kitchen grease; into this a quantity of the ley is poured, or pumped. The mixture is boiled for some time, and frequently stirred, during which time the tallow, &c., unites with all the soda of the ley, leaving the water, which is then pumped away, and a fresh supply of it poured in; this is repeated as often as is required, until the whole of the tallow and grease is changed into soap. The mottled appearance, from which this soap has derived its name, is caused by a small quantity of very strong ley being sprinkled on the surface; this sinks in, and marbles, or mottles, the soap. In order to cool and harden the soap it is removed from the boiler and poured into large pans; and when become a solid mass, is removed, and cut up by wires into the bars in which it is sold.

Curd soap is made in nearly the same manner, pure white tallow, without kitchen grease, being used. When scented, and cast in small cakes, it is sold as Windsor soap. Yellow soap is made with resin and palm oil instead of tallow. It is the resin that gives it the peculiar smell and bitter taste it possesses.

Soft soap is made with pearlash (see PEARLASH) instead of soda, and whale or seal oil used with the tallow.

All the various soaps are soluble in water, forming semi-transparent solutions. If the water containing soap be shaken, or agitated, it retains on its surface the bubbles of air; it is then said to lather.

When wet, or dissolved, soap has a peculiar feel, which is so unlike that of other bodies that it is distinguished by the term soapy. The great use of soap depends upon its dissolving in water, and upon its power of removing grease and dirt. This effect is owing to the caustic alkali

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348. What variety of soaps is spoken of?
349. Name the properties and uses of soap.

it contains. It may be asked, would it not be better to use the caustic soda by itself, instead of mixing it with tallow? It would not, because its action would be too violent—it would burn and destroy; whereas, when made into soap, it retains much of its power of purifying without any of the destructive effects of its caustic nature.

Sponge.—The substance so well known by this name is an animal product, which is found attached to the rocks under water in the Mediterranean and other seas.

Sponge is a light, soft, and highly elastic material, very easily compressed, and rapidly resuming its original shape when the pressure is removed. It is exceedingly porous, containing an immense number of small tubes, which communicate with some larger apertures that are found in it. The substance of the sponge consists of horny elastic fibres, and these are so placed as to form the tubes and pores described.

When the sponge is in the sea, alive, the inside of the pores are covered with a soft substance, like white of egg. This appears to be the flesh of the animal, and currents of water may be seen running into the sponge through the small pores, and out of it through the large ones; and it is supposed that whilst the water is passing through the sponge, the nourishment requisite for the support of the animal is extracted from it.

When the sponge is removed from the water, this soft flesh drains away, leaving nothing but the elastic fibrous substance with which we are acquainted.

The use of sponge, as a material for washing with, depends chiefly on its being so highly porous and elastic. When placed in water its pores become filled with the liquid. If in this state it is compressed, the water is readily forced out over any thing it is desired to clean, and as soon as the pressure is taken away the sponge resumes

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350. What is sponge, and where obtained?
351. Describe its structure and properties.
352. How is it procured from the ocean?

its former size, and its pores are again open to suck up a fresh supply of fluid, if required.

The sponge we use comes chiefly from the Mediterranean Sea, where it is procured by diving, and also by dredging, or dragging the bottom of the ocean. The best sponge, which is white and fine, comes from Turkey; the inferior and coarser kinds from the coast of Barbary. Ten or eleven kinds of sponge are found on the coast of England—none of them are fit for use.

TORTOISE-SHELL.—This beautiful substance is produced by a sea tortoise, or turtle. The animal from which the tortoise-shell of commerce is obtained is the hawks-bill turtle, a native of the seas of the torrid zone.

Its usual length is about three feet. As in the other animals of the order to which it belongs, it is enclosed in a bony case, formed underneath by the expanded breast-bone, and on the back by the flattened ribs and spine; on this bony arch grow the scales of tortoiseshell. In the hawks-bill these scales of the back are thirteen in number, besides twenty-five small ones at the edge; they overlap one another to a great extent, and are thick in proportion to the size and age of the animal.

The plates or scales are readily removed from the bony arch by heating it over a fire; this process loosens them, and they are easily separated by passing a knife under them. The value of the rough shell is very considerable, the best being worth about three guineas a pound. Frequently it is injured by barnacles, limpets, and other shell fish fixing themselves to the turtle whilst alive. Tortoise-shell is manufactured in a similar manner to horn, a substance which it closely resembles. It is first softened by boiling in salt and water, and is then pressed flat until cold; it is rendered smooth and of uniform thickness by scraping and filing; and if larger pieces are required than can be obtained from single plates, two or more pieces are united together in the following manner. The edges to be joined

353. Whence is tortoise-shell obtained?
354. How is it procured and manufactured?

are sloped off to the distance of about a quarter of an inch from the edge—the margins are so placed as to overlap one another, and pressed together by an iron press—the whole is then placed for some time in boiling water; the two pieces by this means become so perfectly united that the joint cannot be seen. The filings and powder of the various processes are not lost; they are collected and placed in moulds, made of metal, and by the action of pressure and boiling water are formed into any shape that may be desired. As heat is likely to darken the tortoise-shell, and greatly lessen its beauty, it is usually cut into the required patterns by drills and saws, instead of being moulded like horn.

In making small combs, in order to save the tortoise-shell, two combs are formed out of one piece; the teeth of one comb being cut out of the spaces between the teeth of the other. Besides its use for combs, boxes, &c., tortoise-shell is also used for inlaying and ornamenting tables, cabinets, &c. For this purpose it is cut thin, and a bright metal is placed underneath it; this, shining through the thin shell, gives it a brilliant appearance.

Whalebone.—This peculiar substance is not, as its name might seem to signify, obtained from the bones of the whale, but from what forms a substitute for teeth in the Greenland whale, and the kinds more nearly resembling it.

The lower jaw of this animal is very large and spoon-shaped. It is totally destitute of teeth, or any thing resembling them. From the sides of the upper jaw (occupying the usual situation of teeth in other animals) hang the plates or blades of whalebone, about three hundred in number on each side; they are flat, and ranged parallel to each other at right angles to the jaw. Their points and edges next the inside of the mouth are coarsely fibrous, so that they form a sort of strainer, or filter, the lower ends

355. What of making it into combs?
356. What of whalebone, and whence procured?
357. Describe the upper jaw of the Greenland whale.

of the plates being enclosed within the capacious lower jaw. The blades are the longest at the middle of the jaw, and gradually decrease in length towards each end. The usual length of the longest plates is about nine feet, though they sometimes attain that of fourteen or fifteen feet.

The surface of each blade is firm and very compact, and can be readily polished. This substance is easily split in the direction of its length. In the centre, between the two surfaces, it is less compact, being more fibrous, and the point and inside edge are so coarsely fibrous as to form a kind of coarse fringe.

The use of this apparatus to the whale is very great; it is the only means it possesses of securing its food; for although this creature attains the immense length of fifty-five to sixty-five feet, and a girth of thirty or forty feet, with a weight equalling that of two hundred oxen, it feeds entirely on the small pulpy animals that float in countless multitudes in the water of the arctic seas. In order to secure these, it swims with considerable rapidity, the mouth being open. The water rushes in at the fore part, where the plates of whalebone are absent, and passes out at the sides, being strained through the fringe or filter above described, which allows the water to escape, but retains the food of the whale. The passage to the stomach of the animal is of very small size, so as to prevent it from swallowing even the smaller fishes.

The quantity of whalebone yielded by a Greenland whale of full size is about one ton. In colour it is generally dusky grayish black; some pieces are partially, or even wholly white. The first step in the preparation of whalebone is to boil it for some hours in water. This operation renders it soft, and more readily cut; but when it has become cool again, after boiling, it is harder, and of a darker colour than it was before.

Whalebone is used for various purposes. It is split

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358. How is this structure useful to the animal?
359. How is it prepared for use?
360. To what purposes is it applied?

into fibres, which are used instead of hair in making coarse brooms and brushes. It is also employed in great quantities in the manufacture of the stretchers for umbrellas and parasols, for which purpose it is well fitted, by reason of its great elasticity. It is also employed for stiffening women's apparel and is platted into riding-whips.

The white pieces are sometimes cut in thin stripes and made into bonnets, and even, after drying, into artificial flowers.

TEXTILE, OR WOVEN FABRICS,

AND THEIR MATERIALS.

NOTE.—The materials from which our clothing is derived are obtained from both the animal and vegetable kingdoms; it has, however, been thought better to unite the descriptions of them under one head, as the processes they undergo in the course of manufacture are very similar, and needless repetition will be avoided by such an arrangement. The same reason has led to the insertion of a short account of the processes of spinning and weaving.

Spinning.—This process, which consists in uniting the loose fibres of cotton, flax, or wool, &c. into a thread fit for the use of the weaver, is of the greatest antiquity; it is alluded to by Moses in Exod. xxxv. 25, and was at that time evidently an old art. Originally it was performed with the distaff and spindle; the former was a stick about a yard long, with a knob near one end. Around this the flax or wool previously combed, so as to lay the fibres parallel, was loosely twisted. Thus charged, the distaff was held under the left arm, some of the fibres being pulled out by the thumb and fingers of the right hand, and twisted into a thread, which was wound upon the spindle, a rod of wood about a foot in length, having a slit at one end in which the thread could be caught; the other end of the spindle was fastened to a piece of stone or metal to increase its weight; this enabled the spinner to keep it spinning

361. What of the antiquity of spinning, and how performed?

round as it hung by the thread, whilst the fingers were pulling out fresh fibres from the distaff. As soon as the spindle reached the ground, the thread was taken out of the slit, wound on it again, fastened, and a new length commenced. Distaffs and spindles are still used by the peasants in some of the most remote parts of Ireland.

This process of spinning was at length superseded by the use of the spinning-wheel; the cotton or wool, first combed or carded, so as to lay the fibres parallel, is attached to a spindle so fixed that it is made to turn with great rapidity by a strap of leather passing over a large wheel, which in its turn is caused to revolve by the hand or foot of the spinner.

At the present time the spinning-wheel is almost as rarely to be seen as the distaff and spindle, all the varieties of clothing being now woven from thread spun by the aid of powerful and complicated machinery, which acts upon the same principle as the spinning-wheel, although far too intricate to be understood without the aid of a long description aided by numerous illustrations.

Weaving.—Weaving, or the art of making cloth by the interlacing of threads, has been practised from the earliest times. Upon the tombs of the ancient Egyptians are found paintings of looms constructed on the same plan as the hand-loom of the present day; and these were in use in the time of Joseph.

If we examine a piece of any plain woven material, as calico, silk, &c., we find a number of parallel threads running longitudinally the whole length of the cloth; these threads are called the warp. There are also cross threads which pass alternately over and under the threads of the warp; these threads form the weft.

In weaving, the first process is to fix the threads of the warp; in a common loom these are wound as evenly as possible upon a cylindrical beam or roller; a kind of comb

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362. Describe the spinning-wheel and its use.
363. What is weaving, and what of its ancient practice?
364. Define the warp and the weft, and their arrangement.

being used to lay them parallel, and spread them to the required width of the cloth; the warp is then partly unrolled, the ends being fastened to another roller. In order to separate the threads of the warp, so that the thread of the weft may pass alternately above and below them, the contrivances called heddles are used; each heddle consists of two horizontal sticks, one placed a small distance above and across, the other below the warp. These two sticks are connected together by a number of small threads passing from the one to the other, perpendicularly through the threads of the warp; in the middle of each thread of the heddle there is a little eye or loop, through which every alternate thread of the warp is passed, whilst the remaining threads of the warp are passed through the loops of the other heddle.

Each heddle is so fastened that it may be raised up or pulled down about two inches by a treadle moved by the feet of the workman. Now it is evident that if one heddle be pulled up and the other down, half the threads of the warp will be raised, and every alternate one depressed, leaving a space between them through which the thread of the weft can be passed, when it will be over half the threads of the warp and under the other half. If the heddle that is pulled up is now pulled down, and the one that was down pulled up, the position of the threads of the warp is reversed; and if the weft thread be then passed between the two layers, it will be under the threads it passed over before, and over those it was under. As it would be difficult to pass the thread of the weft by the hand, it is wound on a small piece of wood called a shuttle, which is thrown across the warp, and the thread unwinds as it proceeds.

In weaving by hand, the weaver sits at one end of the warp with a foot on the treadle of each heddle, and then takes the shuttle in one hand; he then raises one heddle, by which half the threads of the warp are raised, the other depressed. Through the opening between the threads

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365. Define heddles and their use.
366. What of the shuttle, and why employed?

he throws the shuttle right across from one side to the other: then with a contrivance called a batten, which is like a large comb, he forces the thread of the weft close up to those previously woven. Then, taking the shuttle in the other hand, he raises the other heddle, which reverses the position of the threads of the warp, and throws the shuttle back again; the thread of the weft is then pulled up by the batten close to the last thread, and the process is continued until the whole of the warp is made into cloth by being crossed by the thread of the weft. As the cloth is woven, it is wound upon a roller, so as to be out of the way of the weaver.

In this manner what is called plain weaving is conducted, and some slight variations of the process will be noticed under the heads of the different fabrics described.

The hand-loom, as the instrument is called, which has been described, is rapidly giving place to the employment of the power-loom, in which the various movements described are all accomplished by the force of the machinery, which is moved by steam-engines. The principle, however, is the same.

Raw Cotton.—This extremely valuable substance is the produce of the cotton tree, a plant of which there are several varieties; some distinguished by being annuals, whilst others are shrubby and attain the size of a small tree.

The leaves are deeply notched, or divided into several lobes. The flowers are large, of a sulphur yellow colour, and resemble in formation and appearance those of the single hollyhock; each flower is succeeded by a brownish seed-vessel, which is surrounded by three heart-shaped leaves, toothed at the edge. This seed-vessel when ripe bursts open, and discloses a mass of snowy white cotton, amongst which are the seeds. One variety of cotton much cultivated in China has the yellow tinge that is

367. What is the batten and its use?
368. How has the hand-loom been substituted?
369. What is cotton, and whence obtained?

preserved when woven into the cloth called nankeen. The cotton plant is largely cultivated in India, China, in the United States of America, the West Indies, the shores of the Mediterranean, and almost all the warmer parts of the world.

Whatever variety is cultivated, the cotton is picked out of the open pod whilst the plant is standing in the ground; that portion only being selected which is ripe. It is dried in the sun; and the next object is to separate the seeds, which would otherwise injure the cotton, they being oily. In India this is done by means of two rollers, which are so fixed in a frame as to turn round together, leaving a small space between them; the cotton is drawn through by the turning rollers, but the seeds, being too large to pass, are torn off and separated. But this machine will only free from the seeds about forty-five pounds of cotton in a day; therefore another process is adopted in America. The cotton is placed in a kind of box, one side of which is formed of a grating of strong parallel wires about one-eighth of an inch apart. Close to this box is a roller bearing a number of circular saws, the teeth of which pass through the grating into the box. When the roller is made to turn rapidly, the teeth of the saws drag the cotton through the wire, whilst the seeds, being too large to pass, remain behind. Thus separated from its seeds, the cotton is pressed tightly in bags, and is brought to England under the name of Raw Cotton. [The annual crop of raw cotton in the United States is no less than 500 millions of pounds, upon an average, although 800 millions have been produced in some years when the season was favourable to the crop. Nearly three-fourths of all the raw cotton finds a market in Great Britain.]

The manufacture of raw cotton into calicoes and other fabrics is now entirely accomplished by the aid of complicated machinery, the description of which could not be

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370. Describe the plant, and its cultivation.
371. How is raw cotton gathered?
372. What is the extent of the crop in America?
373. Describe the process of its manufacture.

followed without the aid of numerous engravings, which would be useless in a work of this nature; therefore merely the name and use of each process will be mentioned, without a lengthened account.

In the first place, the cotton is picked by hand, so as to loosen its fibres and free it from dirt. This operation is completed by a machine called a willow, in which the tufts of cotton are torn into separate fibres by rapidly revolving iron spikes. These loose light fibres require to be laid parallel before spinning; this is effected by the carding machine, in which the cotton is passed between what may be likened to two *brushes* of iron wire: these have the effect of laying all the fibres parallel, when they are transferred to the spinning machine, of which there are various modifications, but the effect of all is to form a slight thread fit for the use of the weaver. This is made to vary according to the purpose required; some yarn (as the spun cotton is termed) being fine, for muslin and lace; another kind strong, for coarse work; a third is retwisted, two or three threads together, so as to make the strong and firm material known as sewing cotton.

[The cotton goods manufactured in the United States annually exceed forty millions of dollars in value. In the single town of Lowell, in Massachusetts, more than 8000 persons are employed in the cotton factories, and nearly a hundred millions of yards of cloth are annually produced. The multitude of the cotton factories spread over New England has served to render these wonder-working establishments so common, that they cease to affect us with the amazement and admiration with which they strike a stranger. But to gaze for the first time upon one of the largest of these, and witness the extensive and complicated machinery extending from story to story of the immense building, every part of which is moving like a thing of life, and all impelled by a single ponderous wheel, and keeping busily employed a thousand young ladies from morn till night, and turning out 250,000 yards

374. What of the extent of it in America?
375. What is said of a single cotton factory?

of cotton cloth per week, spinning 600 million feet of thread every working day, and nearly a million every minute, would seem to impress the spectator with sensations like those produced by magic in fabled story.]

FLAX.—The plant known as the common flax is a native of England, and is found abundantly in America and many other parts of the world. The variety most commonly cultivated is an annual, with slender green herbaceous stems, one foot and a half or two feet in height, bearing narrow pointed leaves without stalks, and terminated by elegant blue flowers; each of which is succeeded by a capsule or seed-vessel, containing ten flat oblong seeds of a brown colour. The flax plant is cultivated for two purposes. When the fibres of the stem are required to form lint, or the material of linen, the seeds are thickly sown, so as to cause the stems of the crowded plants to run up high and thin. When the seeds, which are called linseed, are the principal object, the seeds are sown less thickly, and the plants are allowed to remain longer in the ground before reaping.

When ripe, the leaves fall off and the stems turn yellow; the flax is then pulled out of the ground by handfuls; carefully dried in the sun, and then either stacked or stored in barns until the next year, or stripped of its seeds at once, by drawing the ends through an iron comb fixed upright in a block of wood. The seed-vessels, being too large to pass through the teeth of the comb, are torn off, and fall into a basket below; sometimes they are separated by beating. As thus obtained, linseed, or the seeds of the flax, are extremely valuable in the arts from the quantity of oil they contain; in order to extract this for use, they are crushed by immense pressure, and the oil forced out. If they are slightly heated by steaming before being pressed, they yield a larger quantity of oil, although it is rather injured in quality by the warmth. From 100 pounds of linseed are usually obtained twenty-three or twenty-four pounds of oil.

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376. What of the flax plant, and its products?
377. What process separates the seeds?

Linseed oil is one of the cheapest and most useful of our vegetable oils; it is used in large quantities by painters and glaziers, for making paint and putty, and is also employed for other purposes in the arts. Though not unwholesome, it soon becomes rancid and nauseous to the taste; therefore it is unfit for the food of man.

The crushed mass that remains after the oil has been pressed from the seeds, is extremely nutritious, and is much used for fattening cattle under the name of oil-cake.

The skins of the seeds contain a large quantity of mucilaginous or gummy matter, and when boiling water is poured on to them this substance is dissolved, and the solution is called linseed tea. If care be taken that the seeds be not broken, it is quite free from any oily taste.

The seeds ground into powder form what is called linseed meal, a substance much used in medicine, for poultices, &c.

The stems of the flax plant freed from the seed undergo a series of processes to prepare them for the use of the weaver. They are first steeped, or partially rotted in shallow pools of water, in order to cause the fibres of the bark (the part employed) to separate readily from one another; the stems are then dried, by being spread out upon grass and exposed to the sun and air for about a fortnight. The next process removes the central woody portion of the stem, which has been rendered brittle by the steeping the flax has undergone; the instrument used is called a brake. The simplest is a piece of wood, having a long slit in it, and raised on a stand; into this slit a blunt wooden sword fits loosely. If a bundle of flax be laid over the slit and the sword brought down upon it, the woody, brittle part of the stem is broken, by being bent as the sword presses it into the slit. In general, the brake is made of three swords fixed to one handle, and so arranged as to pass between the edges of four others fastened in the frame; thus the flax is broken in four places at once. In some parts of

378. How is their oil obtained, and what are its uses?
379. To what other purposes is it applied?
380. How is the flax itself prepared for the weaver?

England the flax is beaten with a mallet to break and separate the woody portion of the stem. After being thus broken, the pieces of the wood are beaten out from amongst the fibres by a flat wooden staff, or sometimes rubbed out by hand; at the present time, in England, both these operations are performed by machinery.

In order to fit it for the use of the spinner and weaver, the flax has now to undergo the process of heckling, the object of which is to comb out the short, useless fibres, and lay the long ones parallel. The heckle consists of a piece of wood thickly covered with metal points about one or two inches long, so that each heckle may be compared to a brush made of sharp-pointed needles instead of bristles; of these heckles, some are coarse, others fine. The workman, taking a bundle of flax in his hands, throws it on to the heckle, fixed to a stand before him, and drawing the flax through the teeth causes the long fibres to become parallel, whilst the short broken ones are retained by the teeth of the instrument; these latter are preserved and sold under the name of tow. In the flax mills, at the present time, this process is also performed by machines.

As thus prepared, either by the hand or by machinery, the flax is ready for spinning. At the present time nearly all the flax used in England is machine-spun, some being made into yarn for the weaver's use, and a portion is employed in making linen thread, fit for lace-making and needle-work, by two yarn threads being tightly twisted together.

Flax, when woven, yields linen cloth, damask, sheetings, &c. At the present day most of these fabrics are made by the hand-loom, as described in the introduction to this series of articles; the chief stations of the manufacture being Dundee, in Scotland, and the various parts of Ireland. [Excellent linen is now made in America.]

Hemp.—The plant yielding hemp is an annual, a native,

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381. Describe the use of the brake and heckle.
382. What is tow, and how separated?
383. What variety of articles are made of flax?

originally, of the warmer parts of Asia and Europe, but now much more extensively cultivated.

Its stem, which is erect and simple, or unbranched, is from four to six feet in height, and bears numerous leaves, supported on long stalks, and divided into five lance-shaped rough green leaflets, each of which is notched like a saw at the edge; the whole plant is covered with stiff hairs, giving it a peculiar harshness to the touch. The flowers are of two kinds, barren and fertile; they grow upon different plants, and are green and inconspicuous. Each fertile flower is succeeded by a small seed-like fruit, enclosed in the green cup of the flower; the fruit is collected and sold under the name of hemp-seed.

These seeds (as we may term them, in accordance with custom) abound with oil, which they yield readily upon being crushed in an oil press. They are exceedingly nutritious, and are frequently given to birds in confinement. The oil obtained from them is much used in the preparation of varnishes; is sometimes employed in the formation of soft soap; and, occasionally, for burning in lamps.

The hemp plant, especially when grown in a tropical climate, possesses a peculiar narcotic power, and the leaves eaten, or even smoked, when dry, will produce intoxication. For this purpose they are much employed by the inhabitants of the East, to whom the use of wine is forbidden by the Mahometan religion; even the seeds, given in abundance to birds, tend to shorten their lives, and, in some instances, change the colour of their plumage to black.

Hemp is chiefly cultivated for its fibres, which are tough, flexible, and particularly strong; well adapted for the manufacture of coarse fabrics, such as sail-cloth, sacking, ropes, string, &c. So great is the demand for it for these purposes, that 600,000 hundredweights are yearly imported into England, chiefly from Russia. [Hemp is one of the products of Kentucky and other parts of the United States.]

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384. Where are there manufactures, and how conducted?
385. What is hemp, and where cultivated?
386. Describe the plant, its seeds, and oil.

For profitable cultivation hemp requires a sandy, rich soil. The plants, when full grown, are pulled up with the roots, the barren-flowered being first selected, whilst the fertile are left some weeks, in order that the seeds may ripen; the latter is readily rubbed out by hand. The roots and leaves are then removed, after which the stems are placed in water to rot, so that the fibres may be the more readily separated from each other. The operation of rotting the hemp renders the water poisonous, and gives rise to offensive and pestilential odours; when it is concluded the hemp is beaten and heckled, like flax, and finally spun into yarn fit for the weaving of canvass, sackcloth, sail-cloth, &c. &c. It is also used for the formation of string, cables, and ropes of every description. The length of each fibre of hemp being but between three and four feet, it is obvious that to make a string several fibres must be so twisted as to hold firmly together; this process is usually performed by hand. The spinner, taking a bundle of heckled hemp, wraps it round his waist, bringing the two ends to the front; he then draws out a few fibres, and, twisting them together, fastens them to a hook, which is twirled round with great rapidity by a strap passing over it from a large wheel, turned by a boy. The spinner now walks backwards, away from the hook, and as he does so the part twisted by the twirling hook draws more fibres out of the bundle round his waist, whilst with his hand he regulates their number, and so causes the yarn to be uniform in size.

Cord, or rope, is made by the twisting together a number of yarns. A small number are generally twisted together in the first instance, and several compound ones, so formed, re-twisted into a single cord.

Silk.—The process of the formation of raw silk has already been described, under the head of Silkworm Moth, page 103. We have now to trace its further progress into spun silk, adapted to the use of the weaver and

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387. Name the properties and uses of hemp.
388. Describe the process of its manufacture.

sempstress. The hanks of raw silk are first washed in warm water, and then wound upon bobbins, or reels; this is accomplished by the winding machine, the effect produced by it being the same as when a skein of silk held on the outstretched hand of one person is wound upon a reel by a second. After being thus wound, the fine filaments of silk have to undergo the process of spinning, twisting, or throwing; this is effected by a very complicated engine, termed the spinning machine. For the stouter threads, required for some purposes, several of the threads thus obtained are again twisted together.

The thick, strong, and tightly-twisted silk, known as sewing-silk and twist, is made by hand, in the same manner that hemp is spun into rope, each piece of silk twist being from fifty to one hundred feet in length.

The silk spun for the use of the weaver is usually dyed after it is twisted, being first boiled in soap and water to render it soft and glossy.

The only silk fabrics requiring a particular notice are shot silk, satin, and velvet.

Shot silk is formed by having the warp and the weft of different coloured threads, so that a play of colours is produced as the silk is seen from different points of view.

Satin owes its peculiar lustre and softness to the circumstance of its being so wove that the threads of the warp only are visible, the threads of the weft scarcely coming to the upper surface. This is accomplished by carrying each thread of the weft under five or six threads of the warp, and then over one; again under five or six, over one, and so on. By this means the weft threads are scarcely seen, and a rich, glossy, unbroken surface is produced.

Velvet, the soft pile of which is so peculiar, is formed by weaving short loops of silk into the fabric: these stand at right angles to, and hide both the weft and the warp; they are afterwards cut open by a sharp instrument, and

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389. What of raw and spun silk?
390. How is sewing silk and twist made?
391. What variety of silk fabrics are named?

the ends of the silk standing up from the cloth give to the velvet its peculiarly soft appearance.

The same kind of formation is readily observed in thick hearth-rugs, where the cut ends of short worsted threads rise up from a coarse canvass. [The manufacture of silk is but in its infancy in the United States. In France, however, its value is no less than twenty-five millions of dollars annually. Even this is but a small proportion of the whole amount of manufactured silk, and yet every thread has first to be spun by a little worm, without whose agency we could neither have silk, satin, nor velvet.]

Wool.—From the earliest ages wool has been employed as a material for clothing. We are informed that Laban sheared the wool from the sheep during the life of the animals, as is practised at the present day.

When spun and woven, wool yields two distinct classes of products, woollen and worsted goods. The latter are spun, usually, from English wool, in which the fibres are long and coarse; they are subject to nearly the same process as cotton, and yield flannels, camlet, merinoes, moreens, &c. &c.

Woollen goods, as they are termed, by which is meant the various kinds of broad cloth, kerseymere, &c. &c., are produced from Saxony and Australian wools, in which the fibres are short; and peculiar processes are adopted to produce the soft nap distinguishing cloth.

The woollen manufacture, properly so called, is chiefly carried on in the west of England and Yorkshire. [In America we are fast rivalling Great Britain in our woollen manufactures, which amount in value to nearly fifty millions of dollars annually. We have twenty millions of sheep in the United States, and they yield nearly fifty millions of pounds of wool annually.] For this purpose the wool is first sorted into many different qualities, differing as to fineness, length of fibre, colour, &c. These various

392. Describe the manufacture of each.
393. What of the antiquity of wool clothing?
394. Describe the difference between woollen and worsted.
395. Where are the woollen manufactories?

qualities are next separately washed in hot ley to remove the grease they naturally contain, after which they are generally dyed of the required colour. The next process consists in the separation of the various fibres one from the other, so that the wool shall be in the form of a light downy layer; this is accomplished by the locks of wool being torn apart by the sharp spikes of a machine; but before spinning they are required to be laid parallel; this process also, which in effect is somewhat similar to the heckling of flax, is, as well as the spinning into yarn and the weaving, alike accomplished by machinery.

After weaving, the cloth is felted, or fulled, as it is termed. The fulling-mills are so constructed that the cloth is beaten with heavy oaken hammers for two or three days; this causes the fibres of the wool to lock together so as to hide both the weft and the warp. Cotton or linen goods could not be felted in this way, as the fibres are smooth; but each fibre of wool is covered with a series of rings of scales, like those of a serpent's skin. When woollen cloth is fulled, these scales hook into one another, and the close nap is the result. In a fibre an inch long there are about three hundred rings, or teeth. During the fulling, the cloth shrinks very much, both in length and breadth; cloth one hundred inches wide before fulling is about sixty inches afterwards; but in proportion as it shrinks in extent, it increases in thickness. The cloth, having been fulled, has the nap worked up or raised by rubbing it with teasel-heads; these are the flower heads of a plant, and are covered with small hooks somewhat like what are called burrs by the children in the country; the hooks seizing the nap, loosen and raise it up from the cloth; it is then cut of an even length, and pressed to give a glossy surface.

Worsted goods, made of the long-fibred, coarse English wool, are not fulled after weaving, and hence the fibres of the warp and weft are always visible.

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396. Describe the several processes.
397. What of felting or fulling the cloth?
398. How is the nap raised and glossed?
399. What parts of this manufacture are by machinery?

At the present time every process of the manufacture of worsted goods is accomplished by machinery: the washing and drying of the wool; the combing and spinning of the fibres into the different kinds of yarn required for the various fabrics; and also its weaving when spun.

Worsted thread is formed in the same manner as cotton thread, by the re-spinning two or more simple yarns together.

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400. What is peculiar in worsted thread and cloth?

THE END.

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TREASURY

OF

KNOWLEDGE.

PART III.

INTRODUCTION

TO

THE SCIENCES.

CHAMBERS' EDUCATIONAL COURSE

Entered according to Act of Congress, in the year 1846, by
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INTRODUCTORY OBSERVATIONS

BY THE

AMERICAN EDITOR.

The present volume, as its title imports, is only preliminary to a series of elementary works upon the several departments of Natural Science, skilfully adapted to the instruction of children and young persons, and designed as a help to teachers of schools, who may be desirous of inspiring their pupils with a taste for those higher branches of knowledge which are beyond the usual routine of the school-room.

The "Educational Course" of the Messrs. Chambers, of Edinburgh, has been adopted in preference to any other series extant, for republication in America, because of its merited popularity in the schools of Great Britain, where its practical utility has been proved by the test of experience. The judicious classification of subjects, the plain familiarity of the style, and the simplicity of the illustrations which have been chosen by the editors of this series, are among the distinctive merits which entitle it to preference over any other of the numerous rival publications which have been compiled for kindred purposes, whether in Europe or America.

To teachers, especially, these volumes, as they successively appear, will be found to furnish facilities both for acquiring and imparting knowledge, which they will not fail to appreciate. The present volume, the first of the series, may be regarded as a specimen of the whole. And though not catechetical, yet every paragraph is so constructed as to suggest questions for pupils, such as will render the acquisition of

ideas upon all these topics both pleasant and easy, even though the subjects may be novel to both teacher and scholar.

Or should the teacher prefer to communicate his instructions by oral lectures, he will find on almost every page the materials systematically arranged and adapted to his purpose, and he may then superadd catechetical examinations of his class in his discretion.

In Americanizing the series, the editor of this republication has made alterations in the text conformable to the differences between the two countries, and introduced such new matter upon the several topics as seemed called for in correcting inaccuracies, or for the purpose of rendering the series more useful in the schools. Some additional illustrations have been introduced, and greater amplification has been occasionally made of interesting facts and important subjects, which he hopes will increase the value of the whole. He has been careful to carry out the plan of the original work, by retaining no mere technicalities which could be dispensed with, and none without definitions and explanations. The additions made by the editor will be found included in brackets [ ], and incorporated with the text, preferring this course to encumbering the margin with notes.

In the hope that this improved series of the "Educational Course" will be deemed worthy of extensive introduction into the schools of our country, and contribute to encourage an increasing cultivation of the physical sciences by the young, he only bespeaks for his utilitarian labours in preparing them for republication, the candid judgment of the practical educators of the country, who are best qualified to estimate them as they deserve.

THE AMERICAN EDITOR.

PREFACE.

The present volume, while calculated also for private and self-instruction, is chiefly designed to occupy that part of the attention of young persons at school, which has hitherto been devoted to the earliest of the usual series of scientific books. Not less intelligible than the simplest of that class of school-books, it possesses the advantage of a definite and most important object, inasmuch as it presents a connected and systematic view of Nature. The sciences treated of are Astronomy—Natural Philosophy—Geology and Physical Geography—Meteorology—Electricity and Magnetism—Chemistry—Botany—Zoology—Human Physiology—and Mental Philosophy. The amount of information on each is necessarily not great; but it has been the ambition of the writer that the information given should not be a superficial view of a few unconnected phenomena, but a chain of principles, calculated, in combination, to impress a distinct and comprehensive idea, and to make it possible that even those who leave school at the early age of ten, shall not go into the world without some knowledge of the parts of which it is composed, and the laws by which it is regulated. For the completion of a right elementary education, it is of course deemed necessary by the Editors, that each of the sciences here treated, besides several others, be studied separately, at least to the extent in which they are treated in the respective volumes of *Chambers's Educational Course*.

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INTRODUCTION TO THE SCIENCES.

[In proposing to introduce children to the sciences, with a view to their early cultivation, we are only following the order of nature. In early infancy, every child, by the promptings of instinct, is a naturalist; and though yet unweaned, and unable to learn or speak a single word, begins its observation of the objects which are seen, heard, felt, or tasted, as soon as these senses are developed. The light of a candle, the sound of a rattle, the soft fur on the back of a kitten, the taste of sugar or sweetmeats, all these and the like sensations awaken curiosity, and produce ideas of *things*, even in the infant mind, while *words* are yet beyond either power or comprehension. And the delight with which children look upon domestic animals, as dogs, cats, birds, rabbits, squirrels, fish, flies, and other living creatures,—the pleasure with which they handle them, and play with them, and the interest they take in feeding them and watching their peculiarities and differences, calling their names among their first efforts at speech, all these are so many proofs that the knowledge of natural objects is among the earliest instincts and highest pleasures of childhood. Witness the thirst for ideas which is inspired in children by viewing the moon and stars, in looking abroad upon the earth and the sea, in picking up the pebbles and shells by the shore, and plucking the flowers from the garden, and even the leaves from the trees, making all these the subject of observation, and multiplying questions upon all, which none but a philosopher can answer.

But alas! the artificial instructions of the school-room in letters, syllables, and words, is most unnaturally substi-

tuted for the dictates of nature, all of which are repressed and too often annihilated by school-parrotting, for such is most of the knowledge imparted by those who teach words, not things, and frequently words which are not even the representatives of things. No marvel that so much time is often required to pervert nature, by training children in their A, B, C, and *ab*, *abs*, when the air, the fields, the woods, and the rivers, with their varied inhabitants,—the heavens above them and the earth beneath them,—are the sources of knowledge adapted to their physical, mental, and moral wants, and for which, during the early years of childhood, they long with an ardent intensity of desire. Instead of indulging them, however, they are often cooped up in a close room, placed upright on a bench or stool, and kept for hours together in painful toil, poring over a primer or spelling-book, pursuing word-knowledge, and this at so early an age that health is often overthrown, the spirit broken, and a disgust created for the school and books, which is often incurable.

During the first five or six years of life, both philosophy and experience have taught that children should be permitted to learn *things*, and not be burdened with words, syllables, or even letters as a task. While they roam in the fields, or gambol in innocence among their native hills, or leap in sportive play with their comrades upon the grass on the hill-side, their "youth is renewed like the eagles';" and while a ruddier tint is imparted to the cheek, and a warmer glow to the blood, there will be seen a brighter expression enkindled in the eye, and they will instinctively acquire amid these simple pleasures a habit of observing nature, more valuable to their youthful minds than any early training in the school. Moreover, this habit once formed thus early of studying *things*, will inspire a taste and create a thirst for the knowledge of *words*, which, when the time arrives, will qualify them to use their books and profit by the school, since they will now feel the want of which they before had no consciousness, and for which they had no relish.

To those who have been thus trained, the introduction to the sciences will be but to revive the original bias of

childhood, which if it has not been extinguished by too early confinement in the school, and too exclusive devotion to books, will be found easy to the teacher and delightful to the pupil. And happily for the young, more enlightened views upon the subject of education now prevail than formerly, so that both parents and teachers have learned the folly of too early and too long imprisonment of children within the walls of the school-room. Especially have modern teachers turned their attention to the importance of substituting things for words in their instructions, and availing themselves of the eye as the medium through which to convey knowledge, instead of memorizing mere verbal lessons, without imparting a single idea, or awakening thought. Hence the present is a favourable period to invite the attention of the young to the study of nature, not as the objects around us were looked at, when in early childhood we gazed upon them with curious eyes, and yet understood them not. But we are now to survey the wonderful works of God systematically, and, guided by the lamp of science, our teachers and our book, we are to bear in mind that "it is the glory of God to conceal a thing; and it is the glory of man to find it out."

First of all let us contemplate the]

EXTENT OF THE MATERIAL WORLD.

In whatever place we first become aware that we are living beings, the scene which we survey is limited to a very small part of the whole system of Nature—that is, of what exists among the wonderful works of God. If we look beyond the house in which we live, we probably see other houses, fields, hills, plains, or a part of the sea. If we look upward, a more extensive view is presented; we there behold the clear blue sky, where the sun shines by day, and the moon and stars by night. But even these large plains, and that wide sky, are only a part, and a very small part, of what exists. Far beyond the hills which bound our view, there are other plains and hills; and far beyond the stars which we see by night, there are other stars without number.

Every young person has some notion of the distance

called a mile. If he were to walk a few miles from the place where he lives, he would come to other places quite strange to him; and if he were to walk many more miles, he would still come to new places. The city or town in which he lives is only a few miles in extent; but this is part of a county, which is again part of a state, and this state is but a small portion of the country to which it belongs. The state is probably many hundreds of miles long, and some hundreds broad, and it contains so many people that it is not easy for a child to understand their number. But, after all, a state is only a small part of the surface of the earth.*

It seems strange that it is not a level surface which we stand upon, but a globe, shaped somewhat like an orange. The firm earth beneath our feet is nothing else than a large ball—so large, that the greatest extent of surface which the eye can see at one time appears quite flat. To assure ourselves that the earth is round, we may, on a clear day, look out from some high ground upon the sea,

when we shall see the tops of approaching vessels first appear, and gradually the lower parts.

* An effectual mode of impressing on a young person an idea of the situation of his home upon the globe, may be practised in schools where there are a black board and some maps. On the black board, a ground plan of the school may be given; then a plan of the town, with the school reduced to its comparative size; next a plan of the county or district, with the town reduced: afterwards, the situation of the district may be pointed out in the map of the country, and finally, the situation of the country in a map of the globe. If any care be taken, at the various stages of this process, to give an idea of the relative extent of each place within the other, the pupil will at last arrive at a *comparatively* correct notion not only of the situation of his home, but of the relation borne by the scene within his view to the whole extent of the globe.

1. Describe the form of the earth?

[In eclipses of the moon, the shadow of the earth is seen to be circular, with the naked eye, which proves its spherical form, if there were no other evidence.

But still more certain proof of the globular form of the earth has been furnished by the fact, that ships have often circumnavigated the globe, literally sailing round it. Mr. Cushing, the ambassador to China, has but lately performed this circuitous route, completely round the world, by sailing from America, eastwardly, through the Mediterranean sea, the Red sea, and the Arabian sea, to Bombay, thence through the Indian ocean, and Oceanica, to Canton. On his return he again sailed eastwardly from China, through the Pacific ocean to Mexico, crossing which country, he again embarked in the Gulf of Mexico, and returned through the Atlantic ocean to the point of his own country from which he set out. By tracing the entire journey upon the globe, or map of the world, the form of the earth will be clearly intelligible. It will be found accurately laid down upon the globe map accompanying Goodrich's National Geography.

But so little can we depend upon our senses for correct knowledge of the wonderful works of the Creator, that but for the discoveries of science, we should be altogether deceived, though with our eyes open, even in surveying the earth on which we live. We have just learned that it is not a flat surface, as it appears to the eye, but spherical in its form, and the proofs have been cited. So also to the senses the earth appears to be immovably fixed, while it is ascertained and proved by science, that it has a double motion, one on its own axis, and another around the sun. So that while the earth seems to be stationary, and we appear to be standing still upon its surface, both we and the globe we inhabit are whirling with a rotary motion at the rate of six hundred miles an hour, and around the sun moving more than a thousand miles every minute! and yet without the least evidence to our senses of any motion at all. And however strange this may appear, yet the proofs of this motion of the earth, and the accuracy

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2. What proofs may we have that the earth is round?

of the calculations respecting its rapidity, will be rendered as plain and intelligible as the rotundity of the globe, when we shall have advanced a little farther in the study of Astronomy.]

The earth is about eight thousand miles in diameter or thickness, so that its circumference or girth is twenty-four thousand. Nearly three-fourths of its surface is covered with water, forming seas and oceans. The remainder is very irregular, presenting hills and ranges of mountains, with valleys, slopes, and plains. The land is covered with a great variety of herbs and trees, and inhabited by many kinds of animals. Mankind, either in a civilized or savage condition, occupy the surface, and, as they differ from each other in language and manners, they have arranged themselves into nations, states, and kingdoms.

Although the earth may seem very large, it is, after all, only the third of a set or system of globes, called planets, eleven in number, which move at different distances in space, round the sun, and all of which are supposed to be occupied by living beings, and the things necessary for their sustenance. The moon is a small globe, which moves in like manner round the earth; and some of the other planets have moons moving round them. The sun, which gives light and heat to the planets, is a body of vast size—one million three hundred thousand times larger than the earth. The earth is distant from it ninety-five millions of miles, and the eleventh or last of the planets is distant from it one thousand eight hundred millions of miles. If there were a road from the earth to the sun, and a man were to ride along that road, at the rate of a mile in the minute, which was the speed of the swiftest horse ever known, he would require a hundred and eighty years, or twice the longest lifetime, to perform the journey. Great as is the space occupied by the sun and the eleven planets, it is but

3. Define and state the diameter and circumference of the globe?
4. Proportions of water and land upon its surface?
5. How are mankind divided into nations, &c.?
6. How many planets? Their relation to the sun?
7. What is the moon, and its relation to the earth?
8. What proportion does the earth bear to the sun?
9. What illustration is given?

a small portion of the universe. Every little star which is seen twinkling in the sky is a sun like ours, supposed to be surrounded, too, with a similar system of planets, which, like our earth, are the residences of animated creatures. Though the stars seem near to each other, they are in reality millions of millions of miles distant. Nor do we see all. When we look through a telescope, which is an instrument for bringing within our sight objects too distant to be seen with the naked eye, we discover many more stars; and always the greater power we give to the telescope, we bring more into view. The number of the stars is indeed beyond all calculation.

What is here stated has been made quite certain by the inquiries of learned men; but it does not yet, apparently, comprehend the whole of nature. There is reason for supposing that the stars which we see with the naked eye and the telescope, form but one cluster of worlds moving in space. Far beyond the bounds of that vast cluster, astronomers have perceived what they think may prove to be similar clusters of worlds, but made to appear so small by being far off, that most of them look like little clouds of faint light upon the dark ground of the sky. Indeed it is equally impossible to conceive a limit to space, as to the power of the Creator.

MATERIAL—composed of matter, or that which is perceived by the senses; in opposition to *spiritual*, that which is not perceived by the senses.

NATURE—literally, that which is born, from *natus* (Latin), born; a comprehensive term for the Deity's works, and the laws by which He rules them. The object of science is to discover the character of those works and those laws.

PLANET—from *planao* (Greek), I wander; the planets appearing to shift their places in the sky, while the stars always maintain one place relatively to each other. In distinction from the planets, the latter are called the *Fixed Stars*.

SYSTEM—from the Greek *systema*, a composition: a combination of many things acting together.

TELESCOPE—from the Greek *tele*, far off, and *scopeo*, I look at. This instrument is always in the form of a tube; but one kind is furnished only with lenses, through which the heavenly objects are seen magnified, while of the other kind the principal part is a concave mirror of polished metal, in which a magnified image of these objects is seen reflected.

10. What of the number and distance of the stars?

THE STARS.

As already mentioned, the stars are supposed to be suns, or centres of light and heat, with planets revolving around them. The naked eye can only discern about a thousand, which have been classed in six *magnitudes*, with a regard to their various degrees of light; the largest stars being of the first magnitude, the next largest of the second magnitude, and so on. But when telescopes are employed, vast numbers, which are invisible to the naked eye, are brought into sight. [200,000 stars have been registered, but their number is computed by astronomers as not less than 100 millions.] Of the first magnitude, there are about twenty stars; of the second, about sixty. Many of these have particular names, which were given to them long ago by astronomers. Of the third magnitude, there are about two hundred. The visible stars are scattered irregularly over the heavens; and in some instances a few, taken in combination, form figures which may be likened to familiar objects upon our earth. For instance, a group in the northern part of the sky resembles an animal with its tail thrown far out behind its body; while another group, which in winter we see in the south, suggests the figure of a man with a belt, and a sword by his side.

It has been found convenient by astronomers, to suppose the whole of the visible stars as forming figures, in order that the situation of any particular star may be readily described by one person to another. These figures are called *constellations*, a word signifying a number of stars taken together. The cluster resembling an animal with a projecting tail is called the *Great Bear*; the cluster resembling a man with a belt and a sword by his side is called *Orion*, from a fabulous hero of antiquity. The whole expanse of the sky has thus been mapped out into forms of

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11. How are the stars classified?
12. How many have been registered?
13. What number of the several magnitudes?
14. How are groups of stars designated?
15. What are constellations, with examples?

men, women, beasts, fishes, and other objects, all of which are figured upon our celestial globes.

The largest star in the sky is one in the south, called *Sirius*, or the *Dog-star*. From certain calculations, it is known that its distance is not less (however more) than nineteen millions of millions of miles. Light travels at the rate of a million of miles in five seconds: now, it will take a year and a-half to travel from some of those conspicuous stars. Other stars have been calculated to be forty-two thousand times more distant than Sirius: accordingly, the light which they bear in our eyes, when we look at them through a telescope, must have left them sixty-three thousand years ago.

The stars are more numerous in some parts of the heavens than in others. This is owing to the form of the cluster of stars to which our sun belongs. It is shaped like a disc or coin, and our sun is not far from its centre. We of course see more stars when looking towards the extremities of the cluster than when looking towards its sides; just as, if we were in the midst of a strip of plantation, we should see more trees in the direction of its length than looking crossways. The denseness of the stars towards the extremities of the cluster, and the distance at which they are placed from us, causes them to melt into a thin light, which we see in the form of a ring passing across the heavens, and which the ancients called the *Galaxy* or *Milky Way*. A powerful telescope directed towards any part of that galaxy, shows the stars of which it is composed, and how numerous they are.

Some of the more conspicuous stars, when inspected through a telescope, are found to consist of two, which revolve round each other in a greater or less space of time, and are of various colours—some blue, others reddish, and others green. These are called Binary Systems—binary signifying the condition of *two in connection*. Other stars, again, make periodical changes in their size and brilliancy, apparently in consequence of an alternate advancing and

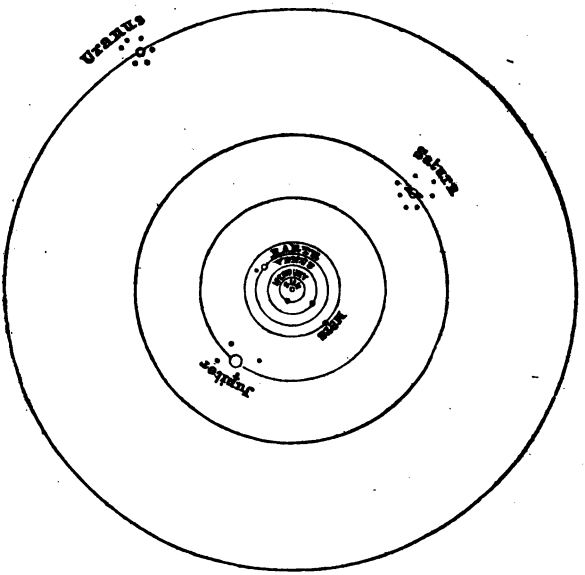
16. What of the largest star?
17. How fast does light travel?
18. What is the milky way, and how formed?

retiring, in and out of our sight. Some of these grew less and bigger in the space of two or three days; others in all spaces of time within five hundred years.

GALAXY—from the Greek *gala*, milk; the appearance of this object being somewhat like that of a stream of milk.

SOLAR SYSTEM.

The sun, and the planets which circle around it, are called the Solar System—*solar* signifying what belongs to

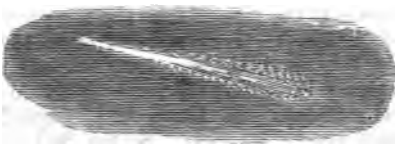


the sun. It is here represented. [This diagram should be imitated upon the slates by the children, and upon the blackboard by the teacher, or the larger pupils. A *living orrery* may be constructed upon the playground by the scholars, personating the sun and planets, respectively, and moving round in their several orbits.]

19. How are binary systems designated?

Here the sun is in the centre, and the planets named Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and Uranus, revolve at various distances around him. Between Mars and Jupiter there are four other planets, not here represented, called Vesta, Juno, Ceres, and Pallas; they are of very small size. In reality, the circuits of the planets are slightly oval, the sun being placed nearer to one end than the other. Each rises and falls, once in its circuit, a little above and below the general *plane* or level which they observe in their revolutions.

Comets are another class of bodies connected with the solar system. Their usual appearance to the naked eye is



that of a star with a long streaming tail. When inspected by telescopes, they are generally found to be composed of a light matter, through which the stars can be seen, while the tail is still more light and vapoury. Some comets have been seen with more tails than one; a comet, in the year 1744, had six. These luminaries differ from the planets in their motions: they travel in all directions far into space, and on their return pass very near to the sun's body. Many hundreds of comets have been ascertained to exist, and the periods at which some approach the sun have been calculated. But new ones are constantly coming under notice. One very celebrated one, called Halley's Comet, on account of the astronomer who first calculated its revolutions, approaches the sun once in seventy-six years: its last appearance was in the year 1835. Another, called, for the same reason, Encke's Comet, performs

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20. What are included in the solar system?
21. What planets revolve around the sun?
22. What are the circuits of the planets?
23. Describe the comets and their variety.
24. What is known of Halley's and Encke's comet?

its revolution in less than four years. The uses or purposes of comets are not known.

Mercury, Venus, and Mars, are about the same size with, or somewhat less than, the earth. An attendant planet or satellite, which we call the Moon, revolves round the earth, at the distance of two hundred and forty thousand miles. Jupiter is the largest of all the planets. Its thickness or diameter is eleven and a half times greater than that of the earth, and it is attended by four satellites. Saturn is of a diameter nine and a half times greater than that of the earth; it is surrounded by two thin plates or rings at different distances, and has seven satellites. Uranus is somewhat less than Saturn, and has six satellites.

The distances of the planets from the sun are as follows: Mercury 37, Venus 68, the Earth 95, Mars 144, Jupiter 490, Saturn 900, and Uranus 1800 millions of miles. Their periods of revolution are respectively, Mercury 88 days, Venus 225 days, the Earth 365¼ days, Mars 687 days, Jupiter nearly 12 years, Saturn 29½ years, and Uranus nearly 84 years.

The sun, when inspected through a telescope, is found to be a body with a luminous exterior or atmosphere, in which small openings occasionally take place, so as to disclose a dark interior. These occasional openings are usually called spots upon the sun, and their existence has been the means of detecting a movement of the luminary upon an axis, corresponding with the direction in which the planets move. The sun requires about twenty-five days to perform this revolution. The planets, besides their motion round the sun, perform, like that luminary, revolutions on their axes, which, in their case, produce the phenomena of day and night. These revolutions are all in a

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25. How far is the moon from the earth?
26. How does the magnitude of Jupiter compare with the earth?
27. What of its satellites?
28. What is peculiar about Saturn and Uranus?
29. Name the distances of the several planets.
30. What of their periods of revolution?
31. Describe the nature of spots in the sun.
32. What of the revolution of the sun upon its axis?
33. How do the other planets perform their revolutions?

particular direction, which can only be described conveniently by saying that it is from west to east.

COMET—from the Latin *coma*, hair; comets are so named from the streaming appearance of their tails.

LUMINARY—from the Latin *lumen*, a light: a general term for the heavenly bodies, as they all send forth light.

SATELLITE—from the Latin *satelles*, an attendant.

ATMOSPHERE—from the Greek *atmos*, vapour, and *sphaira*, a sphere. Atmosphere may therefore be defined as a sphere of vapour enveloping another sphere of more solid materials.

AXIS—Latin, the pin on which a wheel revolves. In astronomy, the axis is an imaginary line through the body of a sphere, on which that sphere is supposed to turn.

PHENOMENON, plural PHENOMENA—(Greek)—acts and appearances in nature.

THE EARTH AS A PLANET.

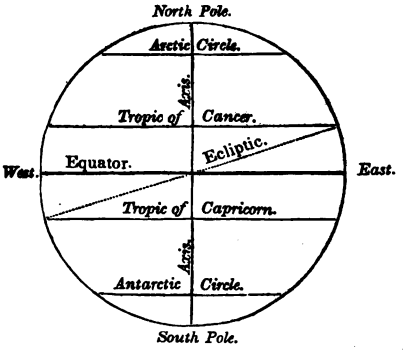
The earth, as already mentioned, is the third of the planets, reckoning them by their distances from the sun. It is a globe of 7902 miles in diameter, and is surrounded by an atmosphere of about forty-five miles in height, the purpose of which is to support animal and vegetable life. It is provided with one satellite or moon, which revolves around it in nearly twenty-eight days. Its own revolution round the sun is performed in 365 days, 5 hours, 56 minutes, and 57 seconds, which constitute the space of time called a year. Its revolution on its axis is performed in twenty-four hours, or one day.

For the sake of convenient description, the figure of the earth has been marked with various imaginary points and lines, which it is necessary to understand before we can well acquire any knowledge of either the heavens or the earth.

Let it first be understood that the direction from which the earth moves is called the *west;* that towards which it moves, the *east;* that the point which is on the right hand of one standing with his back to the east is called the *north;* that on the left hand the *south.* Those who first

34. Describe the earth and its revolutions.
35. What of the moon?
36. Describe the points of the compass.

inquired into these subjects, imagined the earth to move in its daily revolution upon a pole, such as is actually used in the construction of our artificial globes: the point towards the north they call the *North Pole*, that towards the south



the *South Pole;* and as they dwelt on a part of the earth nearer the north than the south pole, they supposed the former to be uppermost, though in reality such ideas as upper and under do not belong to astronomy. It is for this reason that, in globes and maps, the northern part is always placed uppermost, the east being towards the right, and the west towards the left hand, with the south at the bottom.

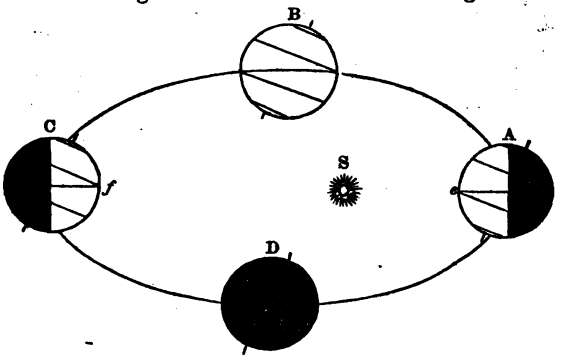
Exactly between the two poles, a line, termed the *Equator*, has been drawn all around the figure of the earth. This has been divided into 360 spaces, termed *degrees*, each of which contains about 69½ English miles. Similar circles, called *Meridian Lines*, have been drawn in the contrary direction, so as to cross the equator at right angles. Ninety degrees intervene betwixt the equator and the pole in each direction. At the distance of 23½ degrees from the equator, to the north, a line parallel to the equator

37. Name the imaginary lines drawn on globes and maps.
38. Define the several lines and tropics.

[The imitation of this diagram upon the slates will be found a useful exercise in *drawing* for the whole school at once, the teacher having previously placed it on the black board.]

has been drawn, and is called the *Tropic of Cancer*, on account of the constellation in the corresponding part of the sky. At the same distance towards the south, a parallel line, called for a similar reason the *Tropic of Capricorn*, has been drawn. The intervening space is called the tropical regions of the earth. At the same distance from the poles, parallel lines have been drawn, which bear the names of the Arctic and Antarctic Circles. Another line, encircling the earth, but touching at opposite points in the tropics, and cutting the equator obliquely, is called the *Ecliptic*. The points where the ecliptic cuts the equator are called the *Equinoctial points*, and when the sun is in that part of his course, the day and night are of equal length. These equinoxes occur twice during the year.

These lines, artificial as they are, refer to natural circumstances. The earth does not move with its pole quite upright or perpendicular, but in an inclined or stooping posture, the departure from the perpendicular being as much as 23½ of the 90 degrees constituting the quarter of the circle. This oblique arrangement produces those beneficial and agreeable variations of heat and light, which



we term the *Seasons*. In the next engraving the sun is represented as nearly in the centre of the oval orbit of the

39. Upon what does the recurrence of the seasons depend?
40. What is the effect of the different positions of the earth?

earth. The earth is seen at four different points in its annual course. At B and D, where it is on the 21st of March and 21st of September, the heat and light of the sun hit it at the equator. When the earth is at A, the upper or north pole is in darkness, and the sun is not there seen for several weeks. When it is at C, the south part of the globe is in the same state. And when one pole is thus darkened, the opposite one has constant daylight for the same length of time. Every day at noon, the earth presents a different part of the ecliptic towards the sun; and his heat is there for the time the most powerful. When the point presented towards the sun is at *e*, which it is on the 22d of December, it is midsummer to all the southern parts of the earth, and winter to all the north. As the exposed part advances towards the point *f*, the northern regions of the earth gradually enjoy more and more heat, till, on the 21st of June, it becomes their midsummer.

The heat of the sun chiefly acts in a direct line, and upon objects which are directly opposed to it. Hence it is chiefly felt within that part of the earth traversed by the ecliptic—in other words, within the tropical regions—where the surface is presented to him at a right angle, or nearly so. The farther a place is to the north or south of those regions, his rays strike the surface more obliquely or slopingly, and the climate becomes cooler—till, in the extreme north or south, water is scarcely ever found except in the shape of ice or snow. These variations of the sun's heat are a most important part of the system of nature; for the vegetable productions of the earth, upon which men and animals depend for their subsistence, require, for being ripened, exactly those proportions of cold and warm weather which the sun provides for them, and would cease to exist if these proportions were materially deranged.

As the earth turns on its axis once in twenty-four hours, each place on its surface at the equator moves at the rate of 1042½ miles in an hour, or above seventeen miles in a minute. In places at a distance from the equator towards

41. What of the direct and oblique rays of the sun?
42. How rapidly does the earth move at the equator?

the north or south, the motion is less rapid, as there is there a smaller circumference to wheel round in the same time. Yet at any part in the United States, we may be said to be carried daily through space at the rate of six hundred miles an hour. This turning of the earth on its axis is what causes *day* and *night* to follow each other. In the last figure, one side or half of the earth appears lighted up by the sun, and the other half is in darkness. The globe is constantly in this state; but, in consequence of the turning, every part has its share of light and darkness in succession. In turning from the west to the east, some part is constantly coming within sight of the sun, and at that place the sun appears to be rising. The place moves onward, so as to come more directly under the influence of the sun, until, at noon, it is directly opposite. In proceeding, it gradually leaves the sun behind, until he seems to sink in the west, and night follows. While he seems, however, to be setting at one place, he is rising to another on the opposite side of the globe, and producing every intermediate hour and minute of the day and night at some intermediate place.

For every *degree* of difference in the situation of places along a line from west to east, there is a difference of about four minutes in the time of those places. Thus, when it is twelve o'clock at Boston, it is twelve or fourteen minutes before twelve at Washington, for there are above three degrees of difference in the situations of those places. So, also, when it is half-past four o'clock at Philadelphia, it is twenty-six minutes to five at Baltimore, the one city being nearly a degree to the west of the other. So, also, when it is mid-day in the United States, and all people are up and busy, it is near midnight in China, which is on the opposite side of the globe, and most people are there asleep.

Within the arctic and antarctic circles there is a certain time in summer during which the sun never sets, but

43. What results from this diurnal motion?
44. What illustrations are given of the differences of time by the clock?
45. What of the arctic and antarctic regions?

circles round and round near the horizon; and a certain time in winter during which he never rises. At the poles, these alternate periods amount to the full half of the year.

EQUATOR—Latin, that which makes equal. This line divides the globe into two equal parts.

MERIDIAN—from the Latin *meridies* (instead of *medidies*, that is, *medius dies*,) mid-day. To all the places along one of the meridian lines, the sun is at his greatest height at one point of time.

TROPIC—from the Greek *trepo*, I turn; the place at which the sun appears to turn back.

ARCTIC—from the Greek *Arctos*, the constellation of the Little Bear, in the tail of which is the pole-star, or star nearest to the north pole. *Antarctic*, from *anti*, against or opposite, *arctos*, the Little Bear.

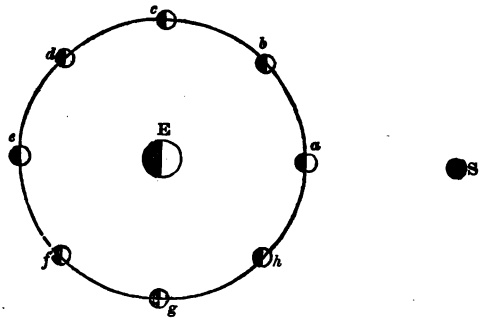
ECLIPTIC—so called from the moon's eclipses taking place when she is in a line with this path of the sun.

THE MOON—ECLIPSES.

The moon is a globe of 2160 miles diameter, which revolves round the earth in twenty-seven days, seven hours, forty-three minutes, and eleven seconds. It has a motion on its own axis performed in the same space of time, and it also goes along with the earth in its circuit round the sun. The moon is not luminous in itself, but only reflects or throws back a little of the light of the sun, which thus becomes what we call moonlight. The changes in the appearance of the moon, from being a thin luminous curve, to a complete circle, are produced in the course of its revolution round the earth. When the moon is at the point farthest from the sun, we, being between the two, see the whole of the lighted side. As the moon advances to a point between us and the sun, the lighted side gradually withdraws from our view, until it is wholly turned away. In the next engraving, the earth E presents a luminous face towards the sun S, while the moon is represented in various parts of her circuit around the earth. At *a* the dark side is towards the earth, at *b* a quarter of the luminous portion is seen, at *c* a half, at *d* three quarters, and at *e* the whole. The moon is then full. It wanes to three

46. Describe the size and revolutions of the moon.
47. Account for the changes in its appearance.

quarters at *f*, to a half at *g*, to a quarter at *h*, and at *a* it becomes entirely dark, and is said to *change*. These variations are called the Phases of the Moon.



If the orbit or path of the moon were always on the plane of the earth's orbit, the moon would, every fortnight, either be between the earth and the sun, or have the earth between itself and the sun. But its orbit rises so much above, and sinks so much below, the plane of the earth, that it rarely causes and experiences this interruption of light. When it intercepts light from us, it is said to eclipse the sun; when light is intercepted from it by the earth, the moon is said to be itself eclipsed.

The lighted surface of the moon, as seen through a telescope, appears full of high mountains, some of which are volcanoes, and frequently spout forth fire and burning matter. Some parts are brighter than others; but there is no appearance of water upon its surface. This luminary not only affords us a partial light, but exercises a powerful influence over vegetable and animal life, and is the cause of the tides. Many of its uses are as yet but imperfectly understood.

The stars, the solar system, and the circumstances con-

48. Describe the diagram of the moon's phases.
49. What of solar and lunar eclipses.
50. What of a telescopic view of the moon.

nected with the earth as a planet, form the subjects of the science of ASTRONOMY.

PHASE—From the Greek *phasis*, the appearance exhibited by any body.

ORBIT—From the Latin *orbis*, a globe, and *itus*, a journey; the curve described by one globe in its revolution round another.

ECLIPSE—Literally a falling away or waning, from the Greek *leipo*, I quit.

ASTRONOMY—From the Greek *astron*, a star, and *nomos*, a law; the science which treats of the nature, distances, and motions of the heavenly bodies, and of the laws by which they are regulated in their courses.

MASSES OF MATTER—LAWS OF ATTRACTION AND MOTION.

All things, of the existence of which we are informed by our senses, bear the general appellation of *Matter*, or more accurately, any thing capable of occupying space, or which has the qualities of length, breadth, and thickness. Any portion of matter is called *a body*. The earth which we inhabit, the air which we breathe, the distant planets and suns, and probably the whole of that space in which the heavenly bodies move, are matter, though some are much more solid or dense than others. A stone, for instance, is denser than water, water again is denser than cork, and cork denser than air; yet all are alike matter. The earth is more solid than the planet Jupiter, which has been ascertained to be as light as water; but still both are alike material.

Matter, in all its forms, is subject to various fixed rules or laws, which have been established by the Creator for very important ends. By one of these, it is ordered that every particle or mass of matter possesses a power of *attracting* other particles or masses. The attractive power of masses of matter is in proportion to their respective sizes, when their densities and distances are the same. Thus, one of those globules of ink which sometimes start from our pen, and settle lightly upon a hair of the paper, will be found to be drawn up towards a larger drop which

51. Define astronomy.
52. What is matter?
53. Define attraction and its laws.

we carefully bring near to it. Thus, also, we often observe that a little stalk of tea, floating in our cup, no sooner approaches the side, than it is suddenly drawn towards it, and settles as closely as it can alongside. *All pieces of matter would be observed to exercise the same attractive influence over each other, if in circumstances equally favourable to allow of a movement.*

The attraction of a body is greatest in its own immediate neighbourhood. The attraction has also a reference, not to the surface of the body, but to its whole mass, the centre being the point where the influence is strongest. At a point twice as far from the centre as the surface is, the attraction is diminished to a fourth of what it is at the surface; at three times the distance, it is only a ninth; at four times, a sixteenth; at five times a twenty-fifth; and so on, the diminution being always as the *squares* of the distances; that is, the distances multiplied by themselves. The distance from the centre of any mass of matter to its surface is called its *semi-diameter;* that is, the half of its diameter or thickness. When we wish, therefore, to ascertain the relative amount of the attraction which any mass of matter exercises over another, we have to inquire how many semi-diameters of the larger the smaller is distant from it, and to multiply that number by itself. The result shows how many times the attraction at this distance is less than at the surface. The moon, for instance, is distant 240,000 miles from the earth; or as much as sixty semi-diameters of the earth; 60 multiplied by 60 gives 3600; consequently, the attraction exercised by the earth upon the moon is a 3600th part of what it would exercise upon the same mass at its own surface.

When the particles of a body can be suspended in the air in a fluid state, they will, if not under the attractive influence of some other body, arrange themselves, by virtue of the same law, around a centre, and take a spherical form. Thus a small quantity of dew suspended on the point of a thorn or leaf, becomes a globule, because, in that

54. What of the centre of bodies, and the semi-diameter?
55. How do we calculate relative attraction?
56. What of the spherical form of bodies?

case, the attraction of the particles towards their own centre is greater than the attraction of any neighbouring body. In consequence of this law of nature, it is considered probable that the globes of space, including our own earth, were originally in a fluid state—that, in that state, they unavoidably assumed a spherical shape, and were then hardened into their present consistency.

Attraction also bears the name of *gravitation*, from a word signifying weight, for weight is entirely a result of the laws of attraction. The attractive influence of the earth pulls down and holds bodies to it. Thus, the falling of a body to the earth is only an effect of attraction, and the weight of a body is only a pressure downwards, in obedience to the same law of gravitation. As gravitation acts upon all the particles or atoms of matter in a body, and not upon the mere surface or superficial bulk, those bodies in which matter is most dense, or have the greatest number of particles, are the heaviest. *All falling bodies tend in a direct line to the centre of the earth, which is the centre of the earth's attractive power;* and therefore, whenever we let fall a body from our hand, it proceeds in a straight line down to the surface, where it is arrested. This is well exemplified by the act of dropping a ball from our hands as we stand upon a slope or mountain side. The ball does not fall towards the centre of the mountain, but in the direction of the earth's centre. What we call *down* and *up* are merely relative terms. That which is down to us, is up in respect to those who live on the opposite side of the globe; and that which is up to us, is down to them.

Attraction, as already stated, is strongest when the bodies are near each other. As we proceed upwards from the earth, it becomes weaker. For this reason, it has not so much strength at the tops of high mountains as at the level of the sea. Weight, consequently, differs in different situations. A ball of iron, weighing a thousand pounds at the level of the sea, if weighed in a spring-balance on the top of a mountain four miles high, will be found to

57. How is weight accounted for?

have lost two pounds of its weight, in consequence of the attractive power of the earth being diminished to that extent at that greater remoteness from the centre. In consequence of its having begun to revolve when in a state of fluidity, the earth at its equator has a diameter exceeding that of its poles by twenty-six miles; consequently, the surface at the poles is thirteen miles nearer the centre than the surface at the equator, a proportion being observed in all intermediate places. Objects are therefore found to weigh more heavily in a spring-balance as we advance from the equator to the poles. From the same cause, objects fall more rapidly at the poles than at the equator. Pendulums, being similarly affected, swing more actively at the poles than at the equator. For this reason, pendulums for regulating the motions of clocks require to be adjusted in length according to the distance of the place where they are used from the equator; because the longer the rod of the pendulum is, it vibrates the slower. A pendulum in Canada would require to be a little longer than one in Washington, in order to vibrate exactly 60 times in a minute.

Gravitation, as already mentioned, does not act on the mere surface of bodies, or according to their bulk, but is exerted in reference to all the particles or atoms individually which compose the mass of a body. In the case of liquids, in which the atoms slightly cohere, the atoms have liberty to spread themselves over the earth, and to seek the lowest situation for repose. In the case of solids, a different operation is observable. In them the particles of matter stick so closely together, that they are not at liberty to obey the laws of gravitation individually, but rally, as it were, round a common centre, upon which the force of attraction may be considered to act for the general behoof. This common centre, or point, is scientifically called the *centre of gravity*. This point in bodies always seeks the lowest level, in the same manner that water seeks the lowest level.

58. Define gravitation and its laws.
59. Illustrate these laws.
60. What differences occur in the weight of bodies, and why?
61. What of the pendulums of clocks?

The centre of gravity in round, square, or other regular shaped bodies, of uniform density in all their parts, is the centre of these bodies. When a body is shaped irregularly, or when there are two or more bodies connected, the centre of gravity is the point about which they will balance each other. The disposition which the centre of gravity in bodies has to seek the lowest level, is the cause of the tumbling or overturning of bodies. Unless the base be made sufficiently broad to prop up the bodies, their heaviest part will fall over. Heavily and highly loaded coaches and carts frequently overturn from the raising of their centre of gravity too high, and from the base or wheels of the vehicle not being wide enough to support them, when any jar occurs. In the various natural structures displayed in the animal and vegetable kingdoms, the centre of gravity is always so situated as to produce a just balance and harmony of parts.

Another of the laws of matter relates to its movements. *Rest and motion* are equally natural to matter, and both alike result from certain circumstances. Thus, for instance, if a cricket-ball be allowed to lie upon the ground, it naturally remains at rest. If it be put into motion, it is natural for it to continue in that motion, in a straight line, until stopped by some resisting force. In the case of a cricket-ball driven by a bat, the air, which is another, though rarer kind of matter, presents a certain amount of resisting force. It encounters another obstruction in the friction or rubbing of its body on the ground; this obstruction being the greater in proportion to the roughness or unevenness of the ground. When at length *as much force has been exerted in stopping it as was exerted in setting it in motion*, it comes to a pause. Being ourselves placed in circumstances where the forces just described are constantly operating, we cannot well conceive that it is equally natural for a piece of matter to remain in motion as to remain at rest, for, on account of those forces,

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62. What is the centre of gravitation?
63. Illustrate this by examples.
64. What of rest and motion?

we always see motion sooner or later brought to a stop. But when we conceive a mass of solid matter set in motion through a space entirely free of all resisting forces, we readily perceive how natural it is for it to continue in motion, seeing that, in such circumstances, an amount of obstruction equal to the impulse is not to be found.

When a body revolves on a centre, the outer parts of course acquire motion. The tendency of the motion of these parts is, in reality, to go on in a straight line. They are only kept within the circle of revolution, because they are fixed. If any piece of the revolving body were suddenly detached or let loose, it would be seen to fly off in a straight line, being forced or impelled to do so by the motive power or force already exerted upon it. We may observe this law operating when we whirl a stone round in a sling. The stone is then felt to have an inclination to start away, and if we suddenly let slip the string, it does start away with great speed. For the same reason, when a mop is twirled, we see each of the threads flying straight out, and they only cease to do so when the twirling is stopped. Motion thus produced is called *centrifugal* (that is, centre-flying) *force*, in distinction from the power of attraction, which is sometimes called *centripetal* (centre-seeking) *force*.

In consequence of centrifugal force, the planets, in wheeling round the sun, have a tendency to fly away into space; and they would fly away, if they were not retained in a particular path or orbit by the attractive power. Thrown outwards by one power, and drawn inwards by another, they have settled into paths where the two forces balance each other, so that they can neither go farther from the sun, nor come nearer to him, than they do. In each case, the size of the planet, the rate of its speed, and its distance from the sun, are circumstances exactly suiting each other; and were there the least change in one, the rest would need to be changed, to preserve the econo-

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65. What of the laws of motion, and how illustrated?
66. What of rotary motion, centrifugal and centripetal forces?
67. What illustration is furnished by the planets?

my of the planet. Were the earth, for instance, made a little larger, and its attraction to the sun thus increased, it would require either to move quicker, or to remove to a greater distance, in order to keep from falling into the sun. Or were the distance of the earth from the sun to be lessened, the earth would equally require to move quicker, in order to keep itself away from the sun. In fact, the earth is, at one time of the year, a little nearer the sun than at another time, and, when nearer, it does move more quickly, and thus maintains itself in its appointed course.

There are many other equally nice arrangements in the planetary system, which show that it must have originated in accordance with fixed laws in nature, and that by these laws it is still sustained. It is supposed that the planets and the sun were originally one soft mass; and that the planets were portions disengaged from the mass, which, by the law of attraction, necessarily assumed a globular shape, and by the laws of attraction and motion together, began a circular revolution in certain orbits. The laws by which these results are supposed to have been brought about appear very simple, for we see them operating in many familiar things on earth; but this apparent simplicity only serves the more expressively to show the greatness of that Power which created both matter and its laws.

All objects connected with moving bodies possess a motion in common with these bodies. Thus, all things on the earth, including the atmosphere, have a motion in common with the earth; a person driving in a chaise has a motion in common with the chaise; a person in a moving vessel at sea has a motion in common with the vessel. In all cases, the motion which is given to any large body passes also into the smaller bodies about or connected with it. This participation of motion in all bodies moving in connected masses, forms one of the most remarkable phenomena in nature. In consequence of it, all objects whatever keep their proper places in or about the large moving bodies with which they are in contact, and hence no con-

68. What of objects upon moving bodies?

fusion arises in the relative situation of objects on the earth from its motion.

For example, when we leap straight upwards from the ground, the earth does not slip away from below us; we fall on the spot whence we arose. Sitting in the cabin of a moving vessel, if we let a small object drop from our hand to the floor, it falls on a point in the floor immediately below; the floor does not leave it behind. The reason is, that the small objects possess an onward motion, which is derived from the larger, and which is retained during their descent. This onward motion remains in the disengaged bodies till they meet some new impression of force—something to stop them. If we attempt to leap from a moving body, such as a coach or a boat, we continue to possess the motion which we previously had, until we reach the earth, when we receive a shock by the destruction of the motion we possessed. If the motion of the vehicle be very quick at the time, it is scarcely possible, in making such a leap, to avoid being pitched forward, by the upper part of our bodies retaining the motion which our feet lose on resting on the ground. The motion we possess in common with the earth, and the perfect smoothness of the earth's motion, render us incapable of feeling our own motion, or of seeing the earth move along with us. Also, in driving in a coach, and looking at the road-side, we feel as if it were not the coach which was running, but the road, which seems to be moving past us.

By the application of a *motive* or *moving* force to solid objects, such as instruments, tools, or machines, very wonderful results are effected; as, for example, when we see a man using a bar or beam to raise a block of wood or stone, which he could not lift by his hands alone. The bar which is used for purposes of this nature is called a *lever*, from a French word signifying to raise. The object which supports the lever where it presses against the ground is called the prop or *fulcrum*. By lengthening the lever between the prop and the handle, we can increase

69. Cite the illustrations.
70. What of a moving force applied to solid bodies?
71. Define a lever and its fulcrum.

the effect, or the power of lifting, to any extent; but the longer or more powerful we make the lever, the longer time is occupied in working it. In this manner power is gained by a sacrifice of time, or a loss of quickness; and

if we wish quickness, we must exert the greater force in proportion. Practically, the loss of time is of no importance, because it would often be quite impossible to raise heavy weights by the united efforts of men's hands, without the aid of some kind of instruments or machines. The purpose of machinery, therefore, is to *lessen and aid human labour*. At an inconsiderable expense, and with a small degree of trouble in attending to it, a machine may be made to do the work of ten, fifty, or perhaps as many as five hundred men; and the work so simply effected by inanimate mechanism serves to cheapen and extend the comforts and luxuries of life to the great body of the people.

The operation of motive forces in connection with solid bodies, forms the subject of the science of MECHANICS, [which includes *mobility* and *weight*, two of the properties of matter, the effects of which are so accurately calculated by this science, that it has been called the "Geometry of Motion."]

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72. What of lengthening the lever?
73. Define the science of Mechanics.

ATTRACTION—from the Latin *ad*, to, and *tractus*, drawn; the power by which all bodies draw lesser ones towards them.

GRAVITATION—from the Latin *gravis*, heavy; that peculiar power of attraction by which bodies, according to their relative weights, are drawn towards the centre of the earth.

STRUCTURE OF THE EARTH—ROCKS AND MINERALS—SOIL.

[THIS department of science, so interesting and useful, is peculiarly fitted to the young, as recent experience amply proves, though heretofore reserved to be taught, if at all, late in life. Every pebble, rock, or grain of sand, awakens curiosity in children, which may be improved by introducing them at once to the alphabet of Geology and Mineralogy, which they will learn as readily and as early as they can be taught the alphabet of their mother tongue. The latter only acquaints them with letters and unmeaning sounds, but the former opens the eyes of the mind, prompts and encourages the habit of thinking, and developes a train of ideas of infinite variety and extent, which at once improves both the mental and moral powers, leading "through nature up to nature's God."

If parents and teachers would avail themselves of the instincts of their youngest pupils, as indicated by their earliest inquiries into the names and nature of the familiar objects which excite their curiosity, they would discover that a thirst for knowledge in natural science is universal in children. And especially are they predisposed to be interested in the structure of the earth, and hence Geology and Mineralogy are full of attraction to the young; and if they are early employed in collecting cabinets of minerals, with specimens of the different materials which compose our earth, and taught to discriminate these by their names, properties, and uses, they will have opened to them an inexhaustible source of instruction and pleasure. By excursions in groups, among their native hills, through the neighbouring fields, and along the margin of rivers, in search of minerals, accompanied by their teacher, their cabinets may be enriched, while their health is improved by physical exercise in the open air, and a taste

at the same time inspired for intellectual pursuits, which will be advantageous to both mind and morals.]

It has been said that the general structure of the earth is solid. As far as man has yet observed, it seems to be composed of various kinds of rocks, earths, metals, and other substances—rocks being the principal material. All these substances constitute what is called the *Mineral Kingdom.*

Some rocks are always found in layers or beds, one above another, like slices of bread laid together, though they seldom lie quite flat or level. They are sometimes found, in this form, extending under great tracts of country. Other rocks are never seen in this form, but always in huge irregularly-shaped masses. In the one case, the rocks are said to be *Stratified*—that is, disposed in strata or layers. In the other case, they are said to be *Unstratified.*

Unstratified. *Stratified.*

If an ignorant person were to inspect the crust of the earth in various places, by looking into quarries, and going down into mines, he would think the various kinds of rock very much confused: he would be apt to see no kind of order in them. It was generally thought that there was no order amongst them, till a period almost within the recollection of persons still living. But it is now ascertained that there is an order in the arrangement of rocks one above another.

First, as to Stratified Rocks: The various kinds are

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74. Describe the general structure of the earth.
75. Define stratified and unstratified rocks.

always found to observe a particular order as they lie one above another in the earth's crust. Thus chalk beds are never found below coal, nor coal below roofing slate, though either chalk or coal may be immediately above roofing slate. The whole of the Stratified Rocks may be said to form a series, as the letters of the alphabet do: there may be present only the first six, corresponding to a, b, c, d, e, f, or only six from different parts of the series, as a, c, h, l, p, t; but whatever are present, an order like that of the alphabet is invariably preserved.*

When we penetrate through the whole of the Stratified Rocks at any particular place, we find the Unstratified, forming, to appearance, the basis or floor on which all the others rest. At many places these Unstratified Rocks rise into lofty mountains, so as to be on a higher level than the Stratified; and the Stratified Rocks are found resting upon, and sloping away from the sides of those mountains. Unstratified Rock is also found to have in some places burst up, in a molten state, through the Stratified, filling vertical openings and chinks in the latter rocks, and even to have spread over them like liquid lava.

The Unstratified Rocks are called *Igneous*, as having been produced under the agency of fire; in the special circumstances where they have been thrown up through openings and chinks, they are called *Volcanic*. The Stratified Rocks, again, have all been laid down as a sediment from water, and are therefore called *Aqueous* or *Sedimentary* rocks.

The Unstratified Rocks are of a hard, crystalline, and sparkling appearance. Four substances enter into their

* The following is another illustration at the command of the teacher: If we take a copy of a book in nine volumes, and range them correctly; then lay them down on their sides, one above another; the second will be found above the first, the third above the second, and so on. Suppose we take out the second and fifth volumes, still the third follows the first, and the sixth follows the fourth: the *order of number* is preserved.

76. What uniform relation of rocks is cited?
77. What illustration is cited of the order of number?
78. Name the varieties of unstratified rocks.
79. What of their composition, and names?

composition, mica, quartz, felspar, and hornblende; and, according as one or other of these substances is more largely infused in the composition, it passes by particular names, as, for example, Granite, Syenite, and Greenstone. *Granite* is generally a grayish shining stone, speckled with green or black, and of extreme hardness. Many ranges of mountains are composed of it. It is useful in building bridges, piers, and other structures designed to be lasting. Waterloo Bridge, in London, is of this stone. The statue of Memnon, and Pompey's Pillar, in Egypt, are composed of it. The city of Aberdeen, near which much granite is found, is entirely built of it.

The first class of Stratified Rocks, being those which lie immediately above the Unstratified, partake generally of the same hard and crystalline character. Indeed one of these rocks, called *Gneiss*, is often so like granite, as to be hardly distinguishable from it. Others, as *Mica Slate*, *Talcose Slate*, *Clay Slate*, are of laminar structure; that is, capable of being cloven into thin slices. Clay Slate is thus fitted for being used in roofing houses, and other purposes. The *Inferior Stratified Rocks* is a general name for this group; they are also sometimes called the PRIMARY, as having been first formed.

Operations which we see going on in nature enable us to form some idea of the way in which the Stratified Rocks have been produced. All stone is liable, when exposed to the air, to crumble away in powder. Water, in the shape of rain, rivers, or waves of the sea, wears it down still more quickly. Hence, there is no rocky mountain which is not constantly getting lower and less, and many coasts are in the course of being worn away by the sea. The particles thus disengaged are generally carried into seas, and deposited at the bottom. In an early stage of the earth's existence, the Unstratified Rocks, originally formed by fire, appear to have been left in immense masses, interspersed throughout very large and profound seas. Matter worn off them would of course settle at the

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80. Name the varieties of stratified rocks.
81. What agent has been employed in producing them?

bottom of these seas, where, pressed by a vast weight of water above, and exposed to the heat which seems to reside in the interior of the earth, they would readily be consolidated into beds of rock.

The wearing down of rocks is constantly going on at the present day, though perhaps to a less extent than in former ages. It is called the *Disintegrating Cause* or *Principle* (*disintegrate* meaning to make a thing not whole —to break it away in pieces). If this law had alone operated from the beginning of the world, all the dry land might have ere now been worn away into the sea, so that there would have been no ground for man or beast to live upon. But there is another law which balances or makes up for it. This is called the *Elevating Cause* or *Principle.* It seems to depend upon the working of fire underneath the crust of the earth. By it the rocks formed at the bottoms of seas are raised, either by sudden convulsions, or gradually, above the level of the sea, so that they become dry land again. Islands have been thrown up in this manner in some seas within the memory of many persons living. There is a tract of country near the mouth of the river Indus, nearly sixty miles in length by sixteen in breadth, which was raised by an earthquake in the year 1819, ten feet above its original level. The shore of the Baltic sea, in the north of Europe, has imperceptibly risen several feet during the last hundred years. This is the reason why sea-shells are often found in great quantities on ground far above the present level of the sea. When new land is thus thrown up, it immediately becomes liable to be worn away again by air and water, and carried back into the sea: so that nature may be said to keep up a constant system of change on the face of the globe.

The matters disengaged from the Unstratified Rocks settled generally in different proportions of ingredients, probably from two causes. First, it may readily be supposed that, when loose matter is carried along by water, the heavier particles necessarily, by gravitation, fall to the bot-

82. What two great principles are recognised?
83. How are islands sometimes formed?
84. What changes result from mechanical action?

tom first, while the lighter particles are carried onwards to perhaps a considerably distant place. Such is the case when the matter is *mechanically suspended* in the water. In other instances, a more intimate or *chemical* union between the water and the matter contained in it, seems to have taken place; and in such cases, by the laws of chemistry, a separation of the ingredients of the matter would ensue. In gneiss, and mica and quartz rocks, we see a separation of materials by mechanical means. In clay slate we see the product of chemical action. Clay, it must be observed, is a substance found in three of the ingredients of granite—mica, felspar, and hornblende. It must have been chemically separated from these, before being laid down in the strata which it has formed. It is generally to be remarked of the mechanically formed rocks, that they are looser and less crystalline in their texture than the Unstratified Rocks. The mica, felspar, and quartz of the original granite are in regular-shaped crystals, with sharp edges, while in the gneiss and mica-slate these crystals are broken into different shapes, and have a water-worn appearance.

A class of Stratified Rocks, usually found next above the Primary, and never divided from these by any other, bear the name of TRANSITION ROCKS, because they partake of the nature of both the Primary Rocks and those which next follow, thus seeming to form a passage between the two. The lowest are chiefly composed of beds of *Sandy Slate*, nearly resembling some of the preceding strata. Next above are beds of a hard rock of grayish colour, composed of fragments of earlier rocks, and called *Greywacke*. Above this is a series of strata, many of which are of limestone, and which are called the *Silurian System*, because found at the surface in a part of England where the Silures lived in the time of the Romans. Still higher is another series, which, from the principal rock found in it, is called the *Old Red Sandstone System*. This system is chiefly composed of beds of *red* sandstone; but in the upper por-

85. What instance of chemical action is cited?
86. What is the next class of rocks called?
87. Name the varieties of transition rocks?

tion, the layers assume a *yellowish* cream colour, and are very soft and fine in texture. Associated with this system are beds of *Conglomerate*, entirely composed of pebbles, from the size of a pea to that of a man's hand, these pebbles being firmly consolidated or cemented together. The beds of this rock, although from twenty to sixty feet in thickness, are simply the gravels of early seas. Puddingstone is another name for it, from its pebbles being crowded together like the fruit in a plum-pudding.

In the greywacke, and the rocks above it, there are found remains of plants and animals which are presumed to have existed upon the earth at the time when those rocks were forming. Such parts of these plants and animals as have been preserved, are all changed into the matter of the rock itself, but retain more or less exactly their original form, and even the minutest traces of their original structure, so that there can be no doubt about what they are. They are called *Fossils*, from their being dug out of the earth. From the whole range of these fossils, we can tell pretty clearly what kinds of plants and animals flourished on the earth during a long course of ages.

In the greywacke group of strata, fuci or sea-plants are found; likewise, remains of corals and sea-molluscs, such as now exist in tropical seas, but not of the same species. In the Silurian series, the sea-molluscs and corals of the greywacke are continued, with the addition of crustaceans, or jointed shell-fish, and annelida, or sea-worms. Among the molluscs was one curled up like a horn snuff-box, the creature living in the outer part: it is called the *Ammonite*. There was also a certain variety of the *Nautilus*, a creature which still exists in tropical seas. It is furnished with a small membrane, which it raises as a sail on the surface of the sea, so that it can skim along like a ship. One particular kind of the crustacea was a small creature

Trilobite.

88. What of fossils?
89. What sea plants and animals are found in these?

possessing a body of jointed plates, and a head with eyes calculated to look upwards from the bottom of the sea: it is called the *Trilobite*. Among the shell-fish of these early ages, there were some which lived upon others, as in the present day. In the Old Red Sandstone, besides all these, there are remains of fishes in great abundance, and of many different species, but considerably unlike any fish now existing, being covered with bony plates instead of scales.

Above the Transition Rocks lies a series of great importance, usually, though for no good reason, called the SECONDARY FORMATION. First in this formation is the *Mountain Limestone* group, which consists chiefly of thick beds of limestone resting upon dark-coloured shale, (stone formed of mud,) and layers of white sandstone. There are at some places six or eight beds of limestone, and at others only one of great thickness, namely, sixty or one hundred feet. This limestone is almost wholly composed of fragments of ancient corals and sea-shells: there were also many *crinoidea*, of which the *Lily Encrinite* may be taken as a specimen; it had a stalk and head like the flower from which it is named, the mouth and stomach being where the cup of the flower is situated, while the basis was firmly fixed to the bottom of the sea. The Mountain Limestone is so named from its being found in elevated positions, such as in the hills of Derbyshire; it is also called the *Carboniferous Limestone*, from its lying immediately under the coal strata which contain carbon or charcoal.

Above the Mountain Limestone there is a set or group of strata, comprising, amongst beds of ironstone, sandstone, and shale, those seams or beds of *Coal* which are so useful in many ways to man. Coal is composed of great quantities of trees and shrubs, which once grew green and beautiful on dry land, but were ultimately washed down into seas, and compressed under beds of mud and the weight of the ocean, till they became a stone-like mass. In many parts of the earth, but particularly in the neighbourhood of New-

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90. What of the secondary formation? its varieties?
91. What is said of coal, and sandstone?

castle, in the north of England, there are a great number of beds of coal, from a few inches to many feet thick, and having beds of sandstone and shale between them. From appearances of the original vegetables still seen in coal, it would seem that those vegetables were the productions of a warm climate: amongst them are ferns and horsetails, of various species, but of the size of trees instead of lowly shrubs—also reeds and other aquatic plants, and some palms. It is inferred from these and other circumstances, that northern countries, now quite temperate, must have at one time been exposed to the same heat which now exists only near the equator.

Above the coal are found beds of sandstone, called, from its colour and situation, the *New Red Sandstone*. Sandstone is in general formed of grains of quartz and other early rocks, worn away, and deposited in the bottoms of seas, where it has been consolidated by pressure, or otherwise. It is well adapted for building, as it takes on a good polish, and is durable. The finest sandstone for building is found at the bottom of the SECONDARY ROCKS, below the Mountain Limestone. It is white in colour, and can be raised in blocks of any size. The famous quarries of Craigleith near Edinburgh, and Cullelo in Fife, yield this kind of sandstone, and the beauty of the city of Edinburgh is in a great measure owing to it.

Next occurs a series of limestone beds, called the *Magnesian Limestone*, from the quantity of magnesia contained in it. Amidst these beds are to be found others, chiefly consisting of marl and gypsum. Limestone is composed of the earth lime, united with another substance called carbonic acid. Whence came the vast quantities of lime necessary to form the great and numerous beds of limestone in almost all parts of the earth, is a question which has not yet been satisfactorily answered: much of it was, perhaps, issued from the interior in springs, and some might be immediately furnished from the bodies of animals and the shells of fish, or from the great beds of calcareous matter

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92. Describe magnesian limestone?
93. Whence is the lime derived?

formed by the coral insect. Marl is a loose earthy mixture of lime and clay, frequently containing a vast quantity of decomposed shells. When there is more lime than clay, it is said to be a *calcareous* marl; when more clay than lime, a *clay* marl; and when the shells are very abundant, a *shell* marl. Gypsum is a peculiar kind of limestone; it is composed of the earth of lime, united with sulphuric acid, and not with carbonic acid, as in the ordinary limestone. After being burnt in kilns and reduced to powder, it forms, when kneaded up with water, what is called Plaster of Paris (gypsum being largely quarried near Paris), of which images, cornices, and other such things are made.

Beds of red or variegated sandstone occasionally lie between the Magnesian Limestone and the next important group of strata, which bears the name of the *Shell Limestone*, from its containing an unusual quantity of the remains of shell-fish. This group is remarkable as the first (reckoning upwards) which contains remains of animals calculated to breathe the atmosphere. They are of the character of reptiles, but of what would now be considered monstrous forms and habits. One kind, called the *Ichthyosaurus*, was about thirty feet long, with the body of a fish, four paddle fins to make its way through the water, and a large mouth like that of a crocodile. Another, the *Plesiosaurus*, was equally large, and somewhat similar, but with a long flexible neck like that of a swan. Low marshy land, with a hot moist atmosphere, is what would suit such creatures; and such, accordingly, is supposed to have been the state of much of the surface of the earth at the time they lived. They occur in many of the higher or later strata, but in none earlier; and hence it is supposed, that, when they came into being, the earth had, for the first time, become fit for the support of animals capable of breathing the atmosphere.

Next occur, mixed with limestone and sandstone, masses of *Rock Salt*, which in some parts of the world, as in the

94. Name the varieties of marl?
95. Difference between marble and plaster of Paris?
96. What class of animals are found in limestone?

west of England and in Prussia, are dug for the purpose of supplying that necessary of life to the inhabitants. Above the New Red Sandstone and Magnesian Limestone series, occurs a set of limestone and sandstone beds, which pass by the general name of the *Lias Group*. Lias is a corruption of the word layers: the rocks it is specially applied to are of a clayey kind, and contain an extraordinary quantity of fossil fish and shell-fish, and also of the remains of the Ichthyosaurus and Plesiosaurus. The principal beds in the Lias Group are known by the names of Lias Limestones and Alum Shale; the latter being the rock from which the pure crystallized alum is extracted.

A series, next above the preceding, consisting of beds of limestone, sandstone, clay, and marl, obtains the name of the *Oolitic Group*, from one particular kind of bed, conspicuous in it, which is termed *oolite*, in consequenee of its being composed of minute *egg-like* grains. A fragment of oolite resembles a piece of the roe of a fish, and hence one kind of it is called Roestone. This group contains vast quantities of fossils, of the kinds above described.

The next group, and the uppermost in the Secondary Formation, consists of beds of bluish clay, green sand, and chalk. It is known by the name of the *Chalk* or *Cretaceous Group*, from *creta*, Latin for chalk. Chalk is a well-known limestone rock, composed of the earth of lime and carbonic acid; it varies from a bluish to a pure white colour, and contains layers of Flint. Flint occurs in nodules from the size of an egg to that of a man's head; these are broken up for gun-flints, or ground down for the manufacture of china, and other purposes.

Although rocks are deposited above each other invariably in this order, it is in few places that all these groups are to be found. In the greater part of the surface of Scotland, there are no rocks above the Transition kind, sandstone and coal beds only occurring in certain districts. In a large portion of England, there are rocks as high as the chalk, besides a few of the still higher strata afterwards

97. What of rock salt and alum?
98. Name the other groups containing fossils.
99. What of chalk and flint?

to be noticed. In the most of places, many of the strata are omitted, such never having been formed there. But, as has been already stated, no one class of rocks is ever found *below* any other rocks which it is here described as *above*. The chalk, for instance, is never found beneath the new red sandstone, nor the coal beneath gneiss or mica-slate. It is of great importance to know these facts, because they enable us to ascertain in what places valuable rocks, such as coal, may probably be found by digging, and in what places they cannot be found. When people were ignorant of the *order* of the rocks, they used to spend vast sums of money in seeking for coal where it did not exist.

As the groups of strata are generally of great thickness, it would have been impossible, in many parts of the earth, to reach any of the lower rocks, if they had remained in the places and positions in which they were at first deposited; and thus many of them would have been quite useless. But the forces which heaved them up from the bottoms of seas have thrown portions of the connected beds into sloping postures, so that, in most places, strata, originally deep in the bowels of the earth, are brought comparatively near to the surface, and, in some cases, exposed in cliffs to the open air. Masses of connected strata are also found, in some places, to have been rent right across the direction of the seams, and one part raised higher than the other, as if we were to cut through a number of slices of bread, and lift the one pile an inch or so above the other, in which case no one edge of a slice would be opposite that from which it was cut. A derangement of this kind in the position of strata is called a *hitch* or *fault* (see fig. in p. 36). The crack or space between is often found to have been filled up by some other substance, which, from its upright wall-like appearance, is called a *dyke*. Miners, in digging a bed of coal or other rock, are often stopped by these hitches, and spend much time and labour in finding where the seam is continued. Nevertheless,

100. What benefit is it to know the order of rocks?
101. How have the deep rocks been brought to light?
102. Define hitch and dyke.

hitches have various and great advantages. They often bring the coal beds nearer to the surface; they throw them into sloping positions, and thus the water which accumulates in mines is carried to a lower level; and being generally composed of firm clay, they prevent the further passage of the water, which is either brought to the surface in springs, or pumped by artificial means.

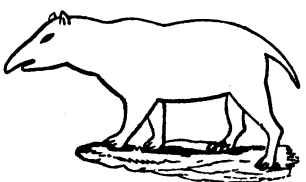
The heaving or elevating cause appears to depend on the expansion and bursting forth of fire from the interior, where the Unstratified Rocks are kept in a melted state. In many places this melted matter has been thrown up along with the fragments of the Secondary Rock, for it is often found strangely mixed with that rock. It seems to have in some cases run into chinks or breaks, which it made in the Secondary Rock in heaving it, and sometimes it has poured over above, and covered the Secondary Rock. When Unstratified Rock has come into existence in this way, it is said to be VOLCANIC. It then bears appearances somewhat different from granite in its original condition. The principal varieties of Volcanic Rock are *Trap*, *Basalt*, and *Porphyry*. In their structure, there are sometimes remarkable peculiarities, certain parts being in neat angular forms, like the crystals in a mass of sugar-candy. The island of Staffa, in the Hebrides, and the Giant's Causeway, in the north of Ireland, are specimens of basalt, in the shape of angular columns or pillars, neatly joined together. Arthur's Seat, Salisbury Crags, and the rock of Edinburgh Castle, are specimens of trap rock. A hill near Glasgow, used as an ornamental burial-ground, is composed mainly of sandstone; but through the centre, the trap, when in a melted state, has forced its way, and spread itself all over the sandstone in the form of an umbrella. In these volcanic processes, as well as in all the other arrangements of the earth's surface, we can trace Almighty wisdom and goodness; they have produced that diversity of hill and valley so necessary to vegetable and animal life, and brought up to the surface those rocks and minerals on which man has so much of his dependence.

At the time when the great chalk deposit, the last of the

103. Name the varieties of volcanic rocks.
104. What changes are ascribed to volcanoes?

Secondary Rocks, was formed, it would appear that a very great unevenness of surface had been produced by the natural operations just mentioned. What is now the Continent of Europe, is supposed to have then been a cluster of islands, with great channels and seas lying between. At this stage, there appears to have commenced a new series of deposits, occupying the troughs or hollows lying between the elevated parts of the solid surface. Paris and London are situated above deposits of this kind. The general name of the TERTIARY FORMATION has been given to these deposits.

The lowest beds of the Tertiary Formation are of *Plastic* or *Soft Clay*, in which are found, for the first time in the series of rocks (with a trifling exception), remains of fresh-water shell-fish. The next beds are of a *Hard and Coarse Limestone* (called, by the French, Calcaire Grossier), containing remains of marine shell-fish. A third group is composed of beds of *Silicious* (that is, flinty) *Limestone*, *Gypsum*, and *Marine Marls*. In the gypsum of this group, as dug near Paris, the first land quadrupeds are found. The globe, when this gypsum was formed, had for the first time become fit for the residence of creatures superior to amphibious reptiles. These land quadrupeds chiefly belong to an order which naturalists call *Pachydermata* (meaning *thick-skinned* animals), of which the elephant, rhinoceros, and common pig, are familiar specimens now existing; but the quadrupeds of the gypsum strata, though of this order and general character, are of *species* which do not now inhabit the earth. They are, in general, of great bulk and peculiar forms. One of the most abundant of these is the Palæotherium, several species of which, varying from the size of a hog to that of a rhinoceros, have been found in the gypsum quarries of Paris, and the fresh-water deposits of the Isle of



Form of Palæotherium.

105. What are called tertiary rocks?
106. Name their varieties, and the fossils.

Wight. It is allied to the Tapir in form, and seems to have been furnished with a prehensile upper lip or trunk something akin to that of the elephant. In the same rocks are found great quantities of the fish and other creatures which had previously existed. The next beds upwards are *Sandstones* and *Marls*, with marine remains. The next and last group contains beds of silicious rock, from which millstones are made, with some marly beds: these appear, from the remains, to have been of fresh-water formation. Three of the Tertiary groups show fresh-water remains, while two between show those of a salt-water kind; whence it may be inferred, that the ground was alternately covered with inland lakes and seas during the formation of those beds. In the earlier Tertiary strata, only three out of a hundred of the shell-fish remains are of kinds now existing. In the higher strata, there are eighteen, and in the highest of all, above ninety, out of the hundred, which still exist. The increase of existing kinds of shells is accompanied, in the higher Tertiary strata, by the extinction of the animals found in the gypsum, and the commencement of animals of the same order, but of existing species, as the elephant, rhinoceros, and hippopotamus; and also of Ruminant Animals, as oxen, deer, and camels. It would thus appear, that, during the deposition of the Tertiary Rocks, the earth was gradually advancing to the condition in which we now find it.

The deposition of the various rocks must have been a slow process, and it is therefore evident that, from the first forming of the globe to the completion of the Tertiary Rocks, an immense space of time must have passed, probably many hundreds of thousands of years. During all this time it contained no human beings, and scarcely any of the quadrupeds or birds which now exist: indeed, it must have been a globe for many ages, before even shell-fish began to live upon it.

After the Tertiary Rocks were formed, the earth seems to have become a scene of frequent and violent inundations, which wore away great quantities of clay, and broke

107. What differences in the character of these fossils?
108. What opinion is expressed here as to the age of the earth?

off vast masses of rock, from various places, and spread the whole together over the surface. These masses of clay, sand, gravel, and pieces of rocks, not being laid down in regular strata like the preceding formations, are generally known by the name of SUPERFICIAL ACCUMULATIONS. The lowest and most extensive of these is a bed of hard blue clay, mixed with water-worn stones of various sizes. It is found in many parts of the world, and bears the name of *Diluvium*, as having been spread over the surface by some great inundation or deluge; the large rounded stones are called *boulders*, or erratic blocks. Above the Diluvium, there are often found beds of *Sand* and *Gravel*, such as are still laid down on the beaches of seas: these places must have accordingly been covered by quiet or ordinary seas at a comparatively recent period. In some places, along the courses of rivers, there are flat valleys, composed of sand, gravel and other light materials. All of these have been formed by the stuff carried down by the rivers from higher grounds. The soil of these places is called *Alluvium*, and the valleys themselves are said to be alluvial—that is to say, composed of matter washed together by the ordinary operations of water. In England, such places are usually called *meadows*, and *dales*, and in Scotland are known by the name of *carses* and *haughs*.

Besides these, there are other superficial accumulations now in process of formation. Large sandy tracts are forming along some parts of the sea-shore, known by the names of *downs* or *links*; and the mud of rivers is creating alluvial land, oftentimes to vast extent, as the *Deltas* of the Nile and Ganges. In most marshy places, certain kinds of plants spring up in great abundance, and the yearly accumulation of their stems and leaves form *peat*; while in such seas as the Pacific, *coral reefs* and islands are formed by the coral insect from limy matter, which it collects from the water of the ocean. On the surface of the dry land, in most situations, we find *Vegetable Soil*,

109. What of diluvium?
110. Define alluvium.
111. How are peat, and coral reefs, &c. formed?

generally a mixture of decomposed rock with decayed animal and vegetable matter. According as the rocks lying below are silicious, clayey, or calcareous, the soil at the place is, generally speaking, of a similar character; and each kind of soil has peculiar properties fitting it for rearing particular kinds of plants. Hence the value of land depends much on the kind of rock which prevails nearest to the surface.

The Primary, and some of the Secondary Rocks, contain numerous rents or veins, which are filled with substances of a different kind from the rocks. In some there are *ores*, from which, by particular processes, we derive the metals used so extensively in the operations of life. The metals are forty-two in number, the most useful being platinum, gold, silver, quicksilver, copper, iron, lead, tin, zinc, and antimony. In the Primary and Unstratified Rocks, we also find those stones which, from their beauty and rarity, have been called *precious*. The chief of these are the diamond, the garnet, the ruby, the sapphire, the topaz, the emerald, the beryl, the agate, the jasper, and the amethyst. The crust of the earth contains a great number of other mineral substances, each of which is found more frequently in connection with one stratified group than with another. The minerals most *useful* to man are building and paving stones, slate, limestone in all its forms from marble to chalk, coal, ironstone, rock-salt, flint, and clay for the manufacture of bricks and pottery.

The annexed table is intended only to show the order of rocks, from the first and lowest upwards to the most recent and superficial. There is also an engraving to exhibit a specimen of the arrangements in which Unstratified and Stratified Rocks are actually found, as they would appear if they were cut through vertically, so as to allow of our having a side view of them.

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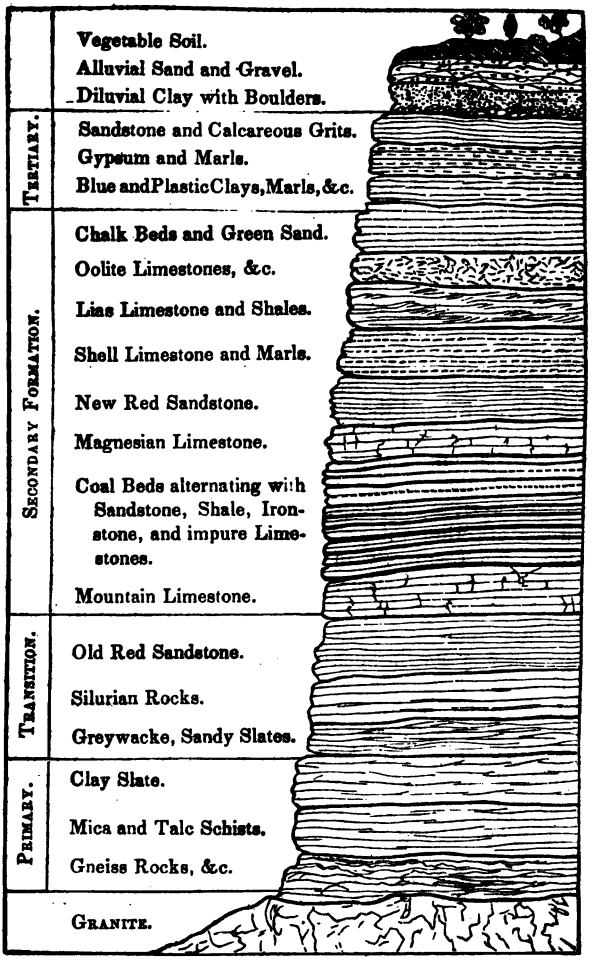
112. How is the value of soils ascertained?
113. Name the number and most useful of the metals.
114. Enumerate the precious stones.



115. Explain the engraving on this page.

SECTION OF EXISTING ARRANGEMENT OF ROCKS.

In the above section, the UNSTRATIFIED ROCKS appear in hills and irregular disrupting masses, from the older granite to the active volcano. The STRATIFIED occur in their regular order. The *Primary* slope from the side of a lofty granitic mountain at a steep angle, and in bent or contorted strata: the *Transition* lie between the ranges of less elevated mountains; The *Secondary* occupy a still less elevated position, the Mountain Limestone being raised up on the hill-side, with the Coal beds thrown into basin-shaped hollows, or broken up by faults, and the Magnesian Limestone and Chalk rising up into slight eminences; the *Tertiary* lie in basin-shaped strata; and the *Superficial Accumulations* occur either as sandy downs by the sea-shore, or as diluvium, with boulders overlying the earlier formations. The pupil will perceive how the Tertiary strata are said to be above the coal beds, though they do not overlie them; and how the coal beds are above the Transition rocks, though removed from each other by a wide extent of country. The lowest strata being formed first, he will also understand why coal is said to be of more recent origin than clay-slate, and chalk younger than coal.

116. Describe the existing arrangement of rocks.

The structure and composition of the earth's crust is the subject of the science of GEOLOGY, so called from the Greek words, *ge*, the earth, and *logos*, a discourse; [and is now understood to treat of the structure and composition of the globe, together with the changes it has experienced since its first existence.] To observe and describe the mineral ingredients contained in the earth's crust, is the object of MINERALOGY. The science of searching for, and working the useful minerals, is called *Mining;* and the art of extracting the metals from their ores, *Metallurgy*. The science which enables men to turn the soil to the best advantage in rearing food, is called AGRICULTURE, from the Latin *ager*, a field, and *colere*, to till.

CRUST OF THE EARTH.—This term is employed to express that outward portion of the globe which is composed of rocks, minerals, earths, &c. The distance between the surface and centre of the globe is about 4000 miles; and as the solid covering may extend to a very small fraction of this depth, the term *crust* has been used to draw a distinction between the outer parts which we know, and the interior parts of which we can only form a conjecture.

SYENITE—so called from Syenna, in Egypt, where this rock is found in abundance. It differs from common granite in being composed of quartz, felspar, and hornblende, instead of quartz, felspar, and mica.

MICA AND TALC.—These are transparent glistening minerals, so transparent, that they are substituted for glass in some parts of Russia. They are occasionally found in large crystals, which can be split up into thin plates; when disposed in small scales, they give the slaty character to those rocks called mica and talc slates.

AMMONITE—(*Ammon*, an Egyptian deity, represented with a ram's head) a fossil shell-fish, so called from its resemblance to a curled-up ram's horn.

TRILOBITE—from its body being composed of *three lobes*.

ICHTHYOSAURUS—from the Greek *saurus*, a lizard, and *ichthys*, a fish; so called from its uniting the form of a lizard with the habits of a fish.

PLESIOSAURUS—Greek, *pleisson*, most or nearest; more nearly resembling a lizard than the ichthyosaurus.

PALAEOTHERIUM—from the Greek *palaios*, ancient, and *therion*, a wild beast; the ancient wild beast. The termination *therium* is very commonly applied to fossil mammalia of the Tertiary strata; as, for example, Megatherium, the great wild beast, Anthracotherium, &c.

DELTA—generally applied to tracts of alluvial deposits formed at the mouth of rivers, from the alluvial land of the Nile, which resembled in shape the Greek letter Δ, or *delta*.

OOLITE—from the Greek *oon*, an egg, and *lithos*, a stone; so named from the resemblance of the stone to the roe or eggs of a fish. *Lite* is a common termination in geology, which the pupil should remember.

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117. Define Geology, Mineralogy, Metallurgy, &c.

SILICIOUS—from the Latin *silex*, flint; flinty, or composed of grains of quartz. Sand is chiefly composed of quartz grains; hence sandy soils are said to be silicious.

CALCAREOUS—from the Latin *calx*, lime; limey, or having a portion of lime mingled up with its substance.

THE EARTH—ITS GENERAL SUPERFICIAL FEATURES.

THE earth, as already stated, is a globe measuring about twenty-four thousand miles in circumference, but a little flattened at either pole, so that its diameter or thickness at the equator is twenty-six miles greater than its diameter at the poles. The substance of its outer part, or *crust*, is solid, being composed of various kinds of rocks and earths, which are elevated and depressed in a very irregular manner. Where these rise to a certain height they form dry land; where they sink into depths and hollows they are generally covered with water. This surface contains 196,816,658 square miles, nearly three-fourths of which are occupied by water, leaving only one-fourth of dry land. This great extent of water is called the *Sea;* it forms an extremely irregular line with the land, and is of various depths, from a few fathoms, to two, three, or even five miles. A large uninterrupted extent of sea is called an *Ocean;* and a large portion of land a *Continent.*

A map of the globe usually presents it in two hemispheres, (hemisphere signifying half a globe,) so as to give us a view of both sides of it. One of these, usually called the *Eastern Hemisphere*, contains one large continent, divided into *Europe*, *Asia*, and *Africa*. In the other, or *Western Hemisphere*, there is a smaller continent, consisting of *North* and *South America*. As America was not known to exist till about three hundred and fifty years ago, it is sometimes called the *New World*, the other continent being, for distinction, called the *Old World*.

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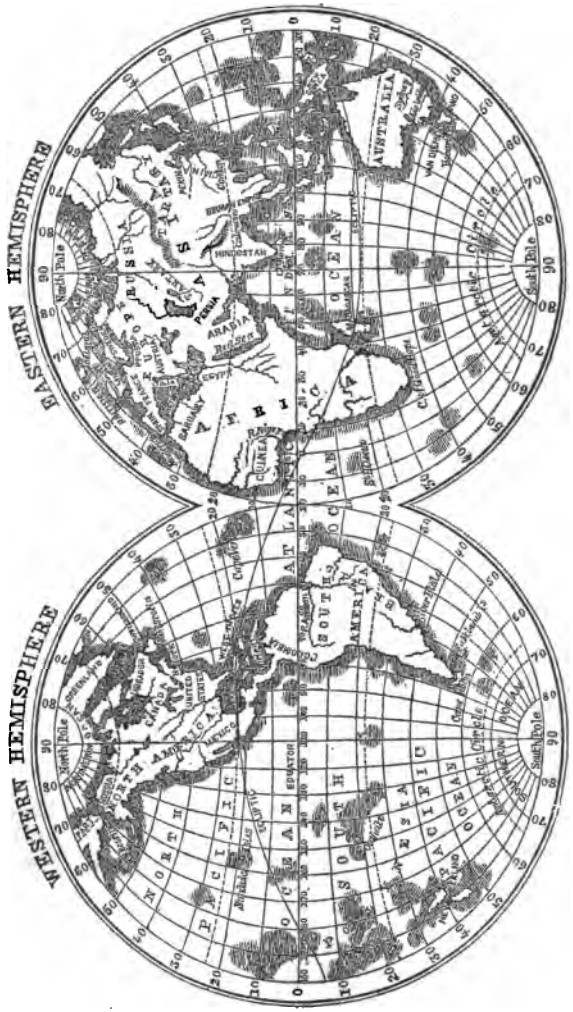
118. Describe the form and measurement of the earth.
119. What of its surface, land, and water?
120. How many hemispheres, their names?
121. What of the continents and their divisions?

MAP OF THE WORLD.



A large extent of sea is called an *Ocean*. America is divided from Europe and Africa by the *Atlantic Ocean*, which is between two and three thousand miles broad. America is divided from Asia by a still larger sea, the *Pacific Ocean*, which is above five thousand miles in breadth. To the south of Asia there is another great sea, named the *Indian Ocean;* and in the neighbourhood of the poles are great seas, respectively called the *Northern* and *Southern Oceans*. Portions of land which are small in comparison with the seas which surround them are called *Islands;* an island being a general term for any piece of land surrounded by water. The largest island is Australia, to the south of Asia; and amongst the most important of the rest are Borneo, Van Diemen's Land, Ceylon, Madagascar, Sicily, Great Britain, Ireland, and Iceland, in the eastern hemisphere; the West India Islands, Nova Scotia, New Zealand, and the Sandwich Isles, in the western hemisphere. A portion of land nearly surrounded by water is called a *Peninsula;* and the narrow neck which connects it with the continent or mainland, an *Isthmus*. A point of land jutting out into the sea is called a *Cape* or *Promontory*.

A smaller extent of water is called a *Sea*. The Mediterranean, the Baltic, the White and Red Seas, are familiar examples. A bend of the sea into the land is called a *Bay* or *Gulf;* a narrow connecting piece of sea, a *Strait* or *Channel*.

The surface of the land is in general very unequal. In some places there are plains little above the level of the sea; in others, there are hills and lofty ranges of mountains. Extensive plains are known as *steppes*, *prairies*, *pampas* or *savannahs;* smaller ones as *valleys*, *straths*, or *dales*. Elevated land is spoken of as rising into *hills* and *mountains*. A tract of high and mountainous ground stretches from the north-eastern extremity of Asia almost directly to the southern extremity of Africa. This tract embraces the Atlai, the Himmalaya, the Donga Mountains,

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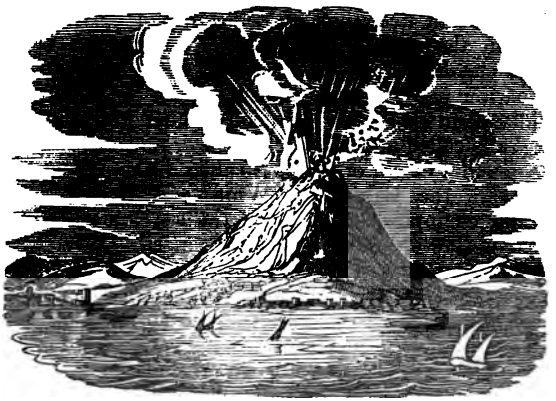
122. Name the various oceans, islands, &c.
123. Explain the technicals italicized.

and other ranges. Another similar tract stretches north and south from one end of America to the other. This tract embraces the Andes in South America, and the Rocky Mountains in North America. The principal mountain ranges besides the above, are the Alps, to the north of Italy; the Pyrenees, between France and Spain; the Uralian, between Europe and Asia; the Dofrafelds, between Sweden and Norway; the Cheviots, between England and Scotland; and the Grampians, in the north of Scotland. Comparatively few mountains are a mile in height. The highest is a peak of the Chumularee in Asia, which is 29,000 feet, or about five miles and three quarters.

Some hills have openings or *craters* at the top, from which they occasionally throw up burning matter or lava.



View of Mount Etna.

together with stones, ashes, and in some instances mud. There are above two hundred such hills: the most remarkable in Europe are Etna in Sicily, Vesuvius in Italy, and Hecla in Iceland; but the west side of America contains

124. Describe the mountains, their course and height.

more than all the rest of the earth. They are evidently the mouths or vents of subterranean fire. They are termed *Volcanoes*, from the heathen deity Vulcan (the god of fire), who was supposed by the ancients to reside under Mount Etna, engaged in forging thunderbolts for Jupiter.

It has been stated that the parts of the earth near the equator are the warmest, in consequence of the rays of the sun falling on the earth most directly in those parts. A belt or zone surrounding the earth between the tropics, and every part of which is liable to be twice a year exposed to the sun's vertical rays, is termed the *Torrid Zone*, on account of the great heat which prevails there. The two similar belts between the tropics and the arctic and antarctic circles are termed the *Temperate Zones*, because the heat of the sun is there more moderate. The remaining parts of the earth, where the sun's rays slant very much, and consequently give little heat, are termed the *Frigid Zones*, or *Polar Regions*. We see the effect of the more direct falling of the sun's rays in gardens sloping to the south. These always produce fruit earlier than gardens which slope to the north. It is supposed that, when the rays of the sun slant at an angle of forty degrees (or nearly midway between perpendicular and horizontal), they lose half their power. Some other circumstances affect temperature. Places elevated considerably above the level of the sea are colder than places in a low situation. Hence, the tops of some mountains, even in temperate and tropical countries, are constantly covered with snow. This height is called the *snow line*, and is found at an elevation of 16,000 feet in the tropics, while in America it is only 5000. The thermometer (an instrument for measuring heat, which will be afterwards explained) falls a degree for every ninety yards we ascend. In the neighbourhood of seas, there is less variation of heat than in inland places. On account of various such circumstances, the average winter temperature of Milan and Edinburgh, for example, is the same,

125. What of the volcanic mountains?
126. Enumerate the divisions of the earth into zones.
127. What circumstances affect the temperature?
128. What of the snow line?

although Edinburgh is almost one-half farther from the tropical region than Milan is.

The surface of the earth is almost everywhere covered by vegetables of various kinds, either growing spontaneously, or cultivated by the hands of men for sustenance and other useful ends. It is essential to the growth of vegetables that they should enjoy heat, light, and moisture. The sun gives them heat and light directly by his own rays: moisture he raises into the atmosphere, where, in the form of clouds, it remains, till, in obedience to certain laws, it descends in rain. The rain soaks the earth, so as to enable it to communicate sap to the vegetables. Much of it also sinks below the surface, to rise in lower levels in the shape of *springs*. Whatever is not taken directly back in vapour, or otherwise used, collects in channels and hollows, in the forms of *rivers* and *lakes*, and ultimately flows back to the sea. And thus more than one important end is served; for not only are the fruits of the earth brought to maturity, but the streams and rivers in their courses supply water for the sustenance of the people living near them, furnish the means of driving machinery, and, when they amount to a great quantity and depth, allow of ships being brought far into the land, for the carriage of goods and transport of passengers.

The various parts of the earth present, in general, the plants and animals appropriate to the prevailing temperature. The shrubs and trees which grow in the torrid zone are in general more luxuriant than those of more temperate climes. In the temperate zones there are many for which the torrid zone would be too hot, and the polar regions too cold. The polar regions, also, have plants fitted by their nature to grow there. Sometimes, in the torrid zone, tropical plants are seen near the bottom of a high mountain; while the middle, being under moderate warmth, shows the plants of the temperate zones; and the top, which is always exposed to great cold, is covered with the mosses and lichens of the polar regions; so that one hill may be

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129. What is the agency of the sun upon vegetation?
130. Name the various uses of springs, rivers, and lakes.

said to afford a specimen of all climates, and all their various productions.

The sea is less liable to variations of temperature than the land. It is affected by waves and currents; and also by tides, which ebb and flow twice in the twenty-four hours. Like the dry land, it is peopled with animals and vegetables adapted to its condition. Plants and animals inhabiting the land are said to be *terrestrial;* those living in sea or salt water, *marine:* and those in fresh-water lakes and rivers, simply *aquatic.* The sea is peopled only at moderate depths, and is supposed to be as void of plants and animals in its deepest parts as those lofty mountains which are perpetually covered with snow.

The external features of the earth, and the mode in which these affect the distribution of plants and animals, form the subject of the science of PHYSICAL GEOGRAPHY.

PENINSULA—from the Latin *pene*, almost, and *insula*, an island; that is, a portion of land almost surrounded by water.

GEOGRAPHY—from the Greek *gę*, the earth, and *grapho*, I write; a writing about, or description of the earth.

PHYSICAL—from the Greek *physis*, nature; hence physical geography relates merely to the *natural* features of the earth, without considering its *artificial* division into states, kingdoms, provinces, and cities, which form the subjects of political geography.

HEAT.

The well-known sensation or feeling of heat is usually confounded with what produces that sensation: we equally speak of the heat of the sun and the heat we feel in our bodies from his rays. In science, the word is properly applied only to what produces the sensation, usually called Caloric, or the matter of heat.

Heat, in this sense, may be described as a thing pervading all the material world, and serving very important ends therein, but the exact nature of which is not known. By some men of science, it is supposed to be a very thin and subtle fluid: by others, it is deemed only a property or affection of matter.

131. How are the plants and animals of the sea designated?
132. What does physical geography teach?
133. In what senses is the word *heat* used?

Some bodies, from their nature, contain more heat than others, and some are more capable than others of receiving and conveying heat. It is a law of nature, that, when two bodies possessing different degrees of heat are brought together, the warmer gives out part of its heat to the colder, till the two come to an equality. Thus, if we were to take a stone into our hand, the hand would give out some of its heat to the stone, till the one was reduced and the other raised so much, that both were alike warm. In this process we should feel the stone at first to be *cold*. This is owing to the departure of the heat from our hand into the stone. So, also, if we were to dip our hands, one into a vessel of very hot and another into a vessel of very cold water, and then both together into a vessel of lukewarm water, the hand which had been in the cold water would feel warm, and the hand which had been in the hot water would feel cold; for in the one case we should receive heat, and in the other give it out. Cold is thus seen to be not a real or positive thing, as heat is, but only a sensation occasioned by a less degree of heat, or by heat going out of our bodies. Cold is, therefore, strictly speaking, only the absence of heat. Even the things which we commonly speak of as the coldest in nature, namely, ice and snow, contain some degree of heat, though a comparatively low one; and heat has actually been brought out of ice, in the shape of sparks, by a particular process.

Some bodies, it was said, receive and convey heat more readily than others. If we stand for some time near a fire, the metal buttons of our clothes will become hot to the touch, while the cloth remains at a moderate heat. This is, because metal receives and conveys heat better than cloth. In metal tea-pots, it is customary to make the handle of wood: this is because the wood does not receive so much of the heat from the water in the tea-pot as a metal handle would do, and is therefore more agreeable to the touch. Were we to take a piece of silver, copper, lead, marble, and clay, of equal sizes, and place them upon the floor of a heated oven, the silver would soon become

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134. What illustration is cited of the nature of heat and cold?

as hot as the oven, next the copper, then the lead, after that the marble, and last of all the clay; so that, while we could put our finger upon the clay without injury, the heat of the silver would be intolerable: silver is therefore said to be a good conductor, clay a bad conductor, of heat. It is a common notion that woollen clothes *give us heat;* but, in reality, their utility arises from their only preventing our own natural heat from leaving us. Bodies which receive and convey heat readily are called by men of science *good conductors*, and bodies of an opposite kind are called *bad conductors, of heat.* Heat conveyed by one solid body to another is said to be *conducted;* when conveyed through liquids, such as water, it is said to be *diffused;* and heated bodies in the atmosphere are said to convey or give off their heat by *radiation.*

When heat in a body is much less than our own natural heat, and therefore not perceptible to our sense, it is called *latent* (that is, hidden or concealed) *heat.* In such circumstances, it can be made manifest by various means. It may be produced by *friction;* that is, by the forcible rubbing of one body upon another. The rubbing of a smooth metallic button upon a board, by which much heat is produced, is an experiment familiar to every schoolboy. Two pieces of wood can be kindled by rubbing them firmly and rapidly together; and the axles of wheels have become red hot by being allowed to run without oil. Heat may be produced by *percussion;* that is, by striking one body forcibly against another. A flint struck rapidly upon a piece of steel gives out sparks of fire, which can kindle tinder or gunpowder. [These sparks are found to be minute particles of iron at a red heat, coated by a thin layer of flint, both these solid bodies being melted by the intense heat produced by percussion.] A piece of iron, by smart hammering upon an anvil, can be rendered so hot as even to kindle the fire of the blacksmith. Heat may also be produced by *compression;* for no body, whether solid, liquid, like water, or gaseous, like air, can be pressed into less bulk without giving out heat.

135. What differences in receiving and conveying heat are named?
136. Define the italicised terms.
137. What is latent heat? and how may it be produced?

The *match syringe* is a familiar example of heat produced by the compression of air. It is an instrument consisting of a brass tube, open at one end, and a rammer exactly fitted to it, on the end of which is a piece of match or inflammable paper: when the rammer is smartly pressed down into the tube, so as to force the air into a small space at the bottom, so great is the heat, that the match takes fire. Further, heat may be produced *chemically;* that is, by the peculiar action of certain bodies upon one another. Sulphuric acid (oil of vitriol), when poured upon water, produces great heat; so does water when poured upon burnt lime. Half-dried hay or grain, when put together in stacks, frequently becomes so hot as to take fire; so ships have been sometimes set on fire by the heat produced among bales of cotton and wool. When substances take fire in this manner, it is said to be by *spontaneous combustion.*

Heat has the effect of keeping the particles of bodies at a certain distance from each other. This effect of heat is said to be a *repulsion* of the particles of bodies; that is, a pushing away from one another. The hardest and most solid bodies are liable to this law; and when their heat is increased, the distance between the particles increases in proportion. Hence a greater degree of heat than bodies receive in their ordinary state *expands* them; a less degree of heat *contracts* them. When a rod of iron is put into a fire, and made red hot, it becomes perceptibly longer and thicker. A small glass globe filled with common air, if held in the flame of a candle, will burst with a loud noise; and the air in a bladder held near the fire will so expand as to tear the bladder asunder. This expansion by heat is so great in some bodies, that no force is able to resist it. Water can be converted into steam, which occupies 1700 times the space of the water; and hence the force of the steam-engine.

It has been stated, that heated bodies radiate their heat through the atmosphere. Substances having a *black* and

138. Name the illustrations.
139. What of the repulsion by heat?
140. What examples of expansion are cited?

rough surface, *absorb* and *radiate* this heat more readily than those which are *white* and smooth. If a piece of black and another of white cloth be laid upon snow, and exposed to the sun's rays, the black will soon be found to have absorbed these rays so as to melt the snow beneath it, while under the white piece no effect has been produced. Smooth and polished surfaces *reflect* heat, as can be easily shown by holding a mirror or piece of polished tin opposite to a bright fire, when the rays of heat will be thrown back or reflected without making the mirror sensibly warmer, while bodies opposite to the mirror will be rendered much warmer. The rays of heat can be collected or *concentrated*, as every boy knows who has ever had a lens of glass, as a sun-glass. Sometimes lenses are constructed of such a size, as to collect the sun's rays in sufficient power to melt gold and iron.

Heat, as a thing pervading all bodies, and keeping them all at a certain degree of expansion, may be considered as one of those elements upon which the existence of the present fabric of the world depends. If heat were suddenly withdrawn from nature, the apparent solid and compact globe would shrink into a much smaller size, and all vegetable and animal life upon its surface would instantly perish. The degree of heat in the atmosphere is called its *temperature;* and for ascertaining this correctly, a very ingenious instrument has been invented. It is called the *thermometer.* It is a glass tube with a bulb at the bottom, into which mercury or quicksilver is put, with a scale of figures along the tube to mark the rising of the quicksilver. The atmosphere affects the metallic fluid in the bulb, and, according to its warmth, causes it to expand and rise in the tube. In the scale of figures, 32 is marked as the *freezing point;* that is to say, when the mercury is at 32, water freezes; and the more it is below that point, the more intense is the frost. When it falls to 0, it is said to

141. What of absorption, radiation, reflection, &c.?
142. What instrument measures temperature?

be at *zero;* at 60, the air is reckoned *temperate;* 98 is the *heat of the blood* in the average of living men; and 212 is the point at which water *boils.* Thermometers are useful for indicating the heat of apartments, and are of service in many of the arts, in which the temperature of the air, or of water or other liquids, requires to be attended to.

[In constructing a thermometer, after the bulb and lower part of the tube has been filled with quicksilver, it is necessary to exclude the air, to avoid the atmospheric pressure. This is done by heating the bulb over a lamp, until the quicksilver boils, when the vapor or steam rises, and forces all the air out of the tube. At this moment, the top of the tube is closed by melting it in the flame of a blowpipe, at the same time withdrawing the lamp from below. The tube is then said to be hermetically sealed.

For graduating the scale, and adapting it to the tube, it is necessary to obtain two fixed points. The first is made by plunging the bulb into a mixture of snow and salt, which when melting produce intense cold. The point at which the quicksilver then stands is marked on the scale, and is called *zero.* The thermometer is next placed in boiling water, and the point at which the mercury now stands is marked on the scale as the boiling point. The space between these two fixed points is now divided into 212 equal parts, called degrees, and it will be found that 32 degrees above zero is the freezing point of water. It is thus that Fahrenheit's scale is constructed, which is most generally used in England and America. In some countries, Reaumer's scale is in use, which has 80° only between the freezing and boiling points of water, while in France the Centigrade scale is preferred, having 100° between the same points.

The method by which the particular scale employed is indicated in the books is by the letter F. for Fahrenheit's thermometer, as 72° F.; and R. for Reaumer's scale, as 72° R.; while 72° C. or Cent. means the Centigrade scale. It will be manifest that very different temperatures are

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143. Describe a thermometer, its construction, and use.

expressed by the same number of degrees, varying according to the scale which is used. For example, the zero of Fahrenheit's scale is 32° below the freezing point; but the zero of Reaumer's scale is at the freezing point. If therefore we read a statement, that the temperature of a given place was 10° below zero, by Reaumer's scale; we would understand that it was not below the zero of Fahrenheit's scale, but several degrees above it. Hence it is important to know that 1° of F. is equal to $\frac{4}{9}$ of a degree of R., and to convert the latter into the former we have only to multiply by 9 and divide by 4; and vice versa. In applying this rule, we shall find that 10° *below* zero of R. is $9\frac{1}{2}$ *above* the zero of F. While the 72° of F. being 40° above the freezing point on that scale, would be nearly 18° of R., and on the other hand 72° R. would be 194° of F., the 32° below the zero of R. being added, this scale commencing at the freezing point, which is at 32° of F. Some thermometers have both these scales, one on each side of the tube.]

RADIATION—from the Latin *radius*, a ray—is that process by which heat is given off in every direction like the rays of the sun.

REFLECT—from the Latin *re*, back, and *flecto*, I bend; the rays of heat and light are said to be *reflected* by mirrors and other polished surfaces. For example, the rays of light falling from the face upon a mirror are bent or thrown back to the eye, and hence we see our own forms reflected.

REPULSION—from the Latin *re*, back, and *pulsus*, driven or thrust—is that property derived from heat by which the particles of bodies thrust each other asunder. Particles so affected are said to be *repelled*.

THERMOMETER—from the Greek *thermos*, heat, and *metron*, a measure; a measurer of heat, or CALORIC, as heat is sometimes called, from the Latin word *calor*, heat.

FROST—SNOW—ICE.

WHEN the heat of the air falls below the freezing point, which it does principally from the weakness of the sun's rays in winter, the phenomenon of frost, or freezing, ensues. Freezing is a process by which water is changed into *ice*. When the heat of the air rises above the freezing point, the ice begins to melt. In freezing, water expands or swells into a greater bulk, and, in so doing, it

often bursts vessels, and even breaks up great pieces of rock in which it may have been confined. Ice is about one-ninth lighter than water, and hence it always floats on the surface. [This is a wise provision of Providence, for if ice were heavier than water it would sink as fast as it formed, and in long winters the whole body of water in rivers might be transformed into ice, and the whole summer would be insufficient to melt it.] It frequently accumulates in vast masses in the polar seas, and is then known by such names as *icebergs*, *floes*, and *ice-islands*. In lofty regions, and on the tops of mountains, where the temperature seldom or ever rises above the freezing point, ice and snow also accumulate in large masses; these masses are known by the name of *glaciers*. Fragments of them, called *avalanches*, sometimes descend with great violence into the valleys below, destroying trees, herds, and cottages.

When the heat of the air is below the freezing point, vapours become frozen, and fall to the earth in the form of *snow*. Rain-drops, frozen in their descent through a cold portion of the atmosphere, form *hail*. When the descending flakes of snow come into a temperature above the freezing point, as they approach the earth, they are apt to melt, and, in such a case, fall in the shape of *sleet*, which is half-melted snow. Light vapours, such as dews and mists, which have been frozen during the night, fall to the earth in the form of *hoar-frost*.

Snow is almost always of a dazzling white colour. When it accumulates on the ground in winter, it is useful in keeping the earth at a moderate degree of cold; for, where the snow lies, the temperature of the ground beneath seldom descends below the freezing point, which is by no means severe. The germs of vegetation are thus kept alive in certain cold countries, where they would otherwise perish.

All liquids do not freeze at the same temperature. For example, olive oil freezes at 50, water at 32, milk at 30,

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144. What of freezing, and ice?
145. Describe the italicised terms.

and quicksilver not till the temperature is so low as 39 degrees below zero. There are several artificial modes of producing intense cold, just as there are of producing heat. [Whenever solid bodies suddenly become fluid, heat is absorbed and becomes latent, hence cold is always produced. This explains what are called *frigorific mixtures.*] The most common method is by pounding ice and common salt, or new-fallen snow and salt, either of which is such a mixture, and will reduce a thermometer placed in it to zero. These mixtures are used for cooling wines and liquors, and also by chemists in some of their preparations.

GLACIER—from the Latin *glacies*, ice—applied to accumulations of ice and snow formed on lofty mountains.

AVALANCHE—from the French *avaler*, to let sink—a mass of snow which falls from the side of a mountain.

LIGHT.

THE nature of light, like that of heat, is a subject of doubt among men of science. It was at one time supposed to be, like heat, an extremely thin and subtile fluid; but the more general opinion now is, that it is produced by a particular agitation in the air, or any other medium through which it may be transmitted. Some of the laws under which light operates have been better ascertained.

Astronomers, having found that a brief interval elapsed between the time when they had calculated upon seeing Jupiter's satellites emerge from behind his body, and the moment when they actually did make their appearance, were led to suppose that light required some time to *travel* through space. On investigation, it was discovered that its speed was at the rate of a hundred and ninety-two thousand miles in a second; consequently, that the light of the sun must take eight minutes in reaching our earth. But, if light be not a fluid, it is improper to speak of its travelling. It would be more correct to say that, at the distance of a hundred and ninety-two thousand miles from

146. What is said of freezing liquids?
147. What of the speed of light?

a luminous object, another object becomes affected by it, after the interval of a second.

Light is said to *radiate* from a luminous object, and to proceed in straight rays. Bodies which allow these rays to pass through them, such as glass, are said to be *transparent;* those which arrest or intercept them, are termed *opaque.* The surfaces of opaque bodies *reflect* light; that is, throw it back. The moon, for instance, reflects the sun's light. When surfaces are smooth and clear, they are particularly adapted for reflecting light, and on this depends the power of a mirror to show us a copy of our own image, or the image of any other object presented to it. Insubstantial as light appears to be, and perhaps is, it observes one of the laws of matter in its reflection, for it strikes a surface and returns from it at the same angle, just as a ball does when thrown against a wall.

Light passing through transparent bodies of uniform density proceeds in straight lines; but when it passes through bodies of different densities, its rays are turned off the straight line. Thus, air and water are of different densities; and hence if we dip a straight rod into water, the portion in the water will appear to be slightly bent upwards. It is this circumstance which causes a pool of water to appear one-fourth less deep than it really is—a fact which it may be of importance to remember, as it may prevent people from rashly venturing into water beyond their depth. Rays turned off the straight line by passing from a rarer to a denser medium, are said to be *refracted.* The refractive power of different media is unequal; though, generally speaking, it may be said to be nearly according to their densities.

If rays of light are made to pass through a triangular piece of glass or other transparent substance, they are found to be changed from their usual pure and clear state into seven colours shading into each other—namely, red, orange, yellow, green, blue, indigo, and violet. A piece of glass constructed for this purpose is called a *prism,* and

148. Define the italicised terms.
149. What illustrates the density of water.
150. What of the refraction of light? the rainbow.

the appearance produced is known by the name of the *prismatic spectrum.* A person standing between the sun and a falling shower sees the same effect produced on the opposite side of the heavens in the shape of a *rainbow;* it is also produced when the sun shines upon the spray of a waterfall or the steam of a steam-engine. This separation of light into various colours is caused by the different degrees of refrangibility; the red being the least, and the violet the most refrangible. A mixture of all these colours produces white; red and yellow form orange; yellow and blue form green; and so on with the rest; a mixture of any two always producing that between them.

Light is also a powerful chemical agent in nature. It is the cause of the green colour so prevalent in vegetables; without it they become white and sickly, do not acquire a woody consistency, and never ripen. Most persons are familiar with the process of blanching celery by earthing it up from the light; or have seen the white and tender stem of a potato which has sprung in a dark cellar. Light is also supposed by men of science to have a similar effect upon animals; those of exposed and sunny climates coming sooner to maturity. Many metallic substances change colour, or become black, on being exposed to light (such as marking ink, which is a preparation of silver;) and dead vegetable matter in general becomes white. This effect of light upon cotton and linen cloth in the process of bleaching is too well known to be described.

The rays of light proceeding from bodies, or reflected from their surfaces, impress the eye with the sensation of light; and hence all the phenomena of *sight* or *vision.* The properties of light, the laws by which these properties are governed, and the various circumstances connected with vision, form the subjects of the science of OPTICS.

LUMINOUS—from the Latin *lumen*, light; any body from which rays of light proceed are said to be luminous, or light-giving.

TRANSPARENT—from the Latin *trans*, through, and *pareo*, I appear; objects which permit light to pass, or be seen through them, are transparent. Glass is a familiar example.

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151. What agency has light upon vegetation?
152. What other effects are ascribed to light?

OPAQUE—from the Latin *opacus*, dark—is the reverse of transparent, and applied to bodies through which light does not pass.

REFRACTION, REFRANGIBILITY—from the Latin *re*, back, and *frango*, I break, *fractus*, broken; rays or lines of light are said to be refracted when they appear to be broken or thrown aside off their usual straight course.

ELECTRICITY AND MAGNETISM.

It was observed in ancient times, that, when amber was rubbed, it acquired a power of attracting or drawing towards it such light bodies as hair and feathers. They called this power electricity, from *elektron*, Greek for amber. At a more recent period, amber, and some other bodies, such as wax and glass, were found to give out, when rubbed, a bright luminous sparkling fluid. The nature of this fluid is as yet a mystery to men of science. As in the case of heat and light, we are only acquainted with a few of the laws under which it operates.

Electricity, like heat, appears to pervade all material things. Like heat, also, it exists in a certain ordinary proportion in each body. It is not then palpable to our senses. By particular operations, a body may be overcharged with it; that is, have more than its ordinary proportion. A piece of glass, when rubbed, becomes thus overcharged, by drawing it from the air. But a body overcharged with electricity, like a body possessing more than its ordinary degree of heat, is liable to discharge the excess into some neighbouring body, so as to return to its usual condition. In the language of men of science, electricity has a tendency to keep in *equilibrium* or *balance* in all bodies. It is when thus collected in unusual quantities in any body, and extending itself into others, that it takes the appearance of a fluid.

When a body has more than its ordinary share of electricity, it is said to be *positively* electrified. But a body in nature may also, by certain circumstances, have less than its share; in which case it is said to be *negatively* electrified. The terms positive and negative are also em-

153. How was electricity discovered?
154. Explain what is meant by equilibrium?

ployed to denote two different states or kinds of electricity. If we suspend a small ball of pithwood by a dry silk thread, and apply to it excited glass and wax alternately, the following phenomena take place. The excited glass rod, on being brought near to the ball, attracts it; and if the glass be gradually removed, and again brought near to the electrified ball, the ball is repelled, instead of being attracted. The same alternate attraction and repulsion takes place when we excite a stick of sealing-wax, and apply to it the ball. But if, when the ball has been electrified by the glass, we apply the excited wax, the ball, instead of being repelled, is attracted; and so also when the ball has been electrified by the wax, the glass, instead of repelling, attracts it. Hence it follows that,

Excited glass *repels* a ball electrified by excited glass,

Excited wax *repels* a ball electrified by excited wax,

Excited glass *attracts* a ball electrified by excited wax, and,

Excited wax *attracts* a ball electrified by excited glass.

From the above facts, it is concluded that there are two opposite electricities; namely, that produced by excited glass, to which the name of *vitreous* or *positive* electricity has been given; and that produced by excited wax, known by the name of *resinous* or *negative* electricity.

[Our own countryman, Dr. Franklin, was among the earliest of the philosophers who distinguished themselves in the investigation of the phenomena of electricity. The terms positive and negative, or plus and minus, to distinguish the opposite electrical states, were introduced by him, and are since generally adopted, together with his theories upon the whole subject, which have supplanted all others.]

Machines have been constructed for collecting electricity, and showing it in a palpable form. A glass cylinder or wheel is made to revolve against a cushion covered with a mixture of tin-foil and quicksilver, the mixture being called an amalgam. The electricity produced by the friction or rubbing, pours in a stream into a phial coated with

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155. What of positive and negative? Dr. Franklin.

tin-foil. From this phial it can be drawn by the knuckle into our own bodies, which, in receiving it, experience a shock or twinge, especially along the arms. The electricity contained in one phial produces but a slight shock; but when many phials are joined together, a shock may be produced sufficient to knock down an ox; and the heat produced by the spark is so intense, as to melt the hardest metals. A combination of such phials or jars is known by the name of an *Electrical Battery*, an improvement first discovered by Dr. Franklin, and since found to be of invaluable importance, for a variety of useful purposes in chemical science.

One class of substances, of which the principal are glass, wax, amber, hard stones of all kinds, dry air, white sugar, feathers, silk, cotton, and wool, are called *Electrics*, as being capable of receiving more than their ordinary share of electricity. They are also called Non-conductors of Electricity, because they do not convey it from one body to another. Another class of substances, of which the principal are the metals, most saline substances, charcoal, and all fluids except oils and dry air, are called *Non-Electrics*, because, though ever so much rubbed or excited, they do not exhibit electricity; they are also called Conductors of Electricity, because they have the power of conveying it from one substance to another.

When the air is much dried in hot weather, it becomes overcharged with electricity, so as to be exactly in the condition of a phial charged by an electrical machine. The disposition to regain its usual condition, or to be restored to equilibrium, then causes it to be exhibited on a very grand scale, flashing from cloud to cloud, or darting into the negatively electrified ground, accompanied by tremendous explosions, and endangering the lives of those who are near it. This manifestation of electricity is known by the name of *Lightning*, and the sound of the explosions by that of *Thunder*. The rolling noise of thunder is caused by repeated echoes of the electric explosion among

156. Describe an electrical machine and battery.
157. Explain the italicised terms.
158. Dangers of electricity, and remedy.

the clouds; just as the report of a cannon would be many times repeated and increased were it to take place amid hills and valleys. The phenomenon of thunder was supposed in ignorant ages to be the voice of an offended Deity, but it is now known to be a natural process, which has the effect of restoring the air to a healthy state, and it must therefore be considered as a proof of the divine goodness.

In descending to the ground, the electricity or lightning is apt to damage churches, houses, and other buildings, and to hurt or destroy those who may be within them. To prevent such evils, a rod composed of metal (metal being a *Conductor*) may be fixed upon the building, rising above it in a spike, for the purpose of attracting the lightning, and descending by the outside of the wall to the ground below, for the purpose of carrying it off into the earth.

[As early as 1749, Dr. Franklin announced his theory for explaining the phenomena of thunder-gusts and of the aurora borealis, on electrical principles. He was the first in the world to suggest the value of pointed rods placed upon the top of elevated buildings, which he affirmed would draw off the lightning from electric clouds without noise or danger. In France, philosophers availed themselves of his theory, and even anticipated him in practically applying it. In 1752, he performed his celebrated experiment at Philadelphia, with a silken kite having a pointed rod attached, and to the lower end of the string was affixed a key, which he held in his hand by a band of *silk*, this being a non-conductor. The result was, that having caused his kite to ascend when a thunder-storm was approaching, and allowing the cloud to pass over it, he found that by touching the key, he received a strong electric shock, and the rain wetting the string, he could draw from the cloud a perpetual stream of electricity. By pursuing his experiments, he found that by similar means he could collect the lightning from the clouds into his own room, and having thus charged his apparatus, he could perform all the usual electrical experiments with the lightning thus drawn from the clouds. It was in imitating his experiments, and carrying out his theory, that Professor

Richman, of St. Petersburgh, killed himself in his laboratory, by the incautious manner in which he attracted the lightning from the clouds for his experiments. But to Dr. Franklin belongs the merit of having the priority in point of time to these wonderful discoveries.

Since then the aurora borealis has been imitated a thousand times by electricity, and artificial lightning in like manner has been produced by this agent, fully confirming the theories of our illustrious countryman.]

The rapidity with which electricity can be conducted along metallic substances has suggested the idea of employing it to convey signals from one part of a country to another. Metal wire is laid down between two places, and the electric signal, which is communicated at one end, is conveyed to the other in an instant of time. This contrivance is called the *Electric Telegraph.* It has also been used in blasting rocks; the powder being ignited by electricity conveyed along lines of wire, instead of being ignited by the slow and dangerous mode of burning matches.

The air is seldom highly overcharged throughout a great space. Hence, thunder-storms rarely spread over many miles of the sea or land. There is almost always a space of time between our seeing the flash of the lightning and hearing the sound of the thunder. This is because sound requires some time to travel to us. It proceeds, in ordinary circumstances, at the rate of 1190 feet in a second. We may thus calculate how far any flash of lightning is distant from us, the number of seconds multiplied by 1190, or 1190 multiplied by the number of seconds, giving the distance in feet, which we may easily reduce into yards and miles. If several seconds elapse between our seeing the flash and hearing the report, we may be certain that the electric action is at such a distance as, to ourselves at least, to involve no immediate danger.

The atmosphere, in certain conditions, shows other wonders arising from electricity. The most remarkable of

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159. What of the electric telegraph?
160. What difference in the travelling of light and sound?

these is the *Aurora Borealis*, a bright pale light which is sometimes at night seen shooting up in streams from the northern part of the sky.

The nervous system of the bodies of animals is supposed to depend in some way upon electricity. In some animals, particularly in a fish called the *torpedo*, the electric power is so great as to communicate a shock when the creature is touched. It appears, in these instances, to be designed as a means of defence against the assaults of other animals.

The electric principle appears to be connected, if not identified, with an affection of matter which passes by the term *magnetism*. This has been found to reside in an unusually large proportion in one of the ores of iron, called the *loadstone*, from which it can be communicated to any other piece of iron by rubbing. Metals thus possessed of the magnetic power attract other pieces of metal, and are found to have what are called *poles*—that is, two opposite points, between which the electric or magnetic influence is perpetually, though invisibly, flowing. The body of the earth seems to be itself affected in this manner, having a stream of magnetism in constant motion towards a shifting point near the north pole; and this is a circumstance highly important to man, who, by poising a magnetized needle upon a central pivot, is enabled, by its always pointing northwards, to know, in any part of the world, by sea or land, the direction in which he is going. A needle properly fitted up for this purpose constitutes the instrument known by the name of the *mariner's compass*.

The phenomena of electricity may be produced either by *friction* (ordinary electricity); by *magnets* (electro-magnetism); by *heat* (thermo-electricity); or by *chemical action* among certain substances (Galvanism, from the name of Galvani, an Italian philosopher). So many discoveries have been made under each of these heads, and such a variety of instruments and apparatus invented to exhibit the phenomena, that each may be considered as a separate

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161. What of animal electricity?
162. Nature and uses of magnetism?

department of science. Subtle as electricity and magnetism seem, man has been able to employ their agency to useful purposes. Besides the mariner's compass, which depends on magnetic influence, he has been able to decompose the hardest metals by the power of electricity; he employs the electric shock in cases of disease; by the rapidity with which electricity is conducted along metallic substances, he has employed it in conveying signals from one part of a country to another; and recently, by collecting it in great force from Galvanic troughs and magnetic coils, he has applied it as a moving power to machinery.

VITREOUS—from the Latin *vitrum*, glass—produced by, or partaking of the nature of, glass.

RESINOUS—produced by, or partaking of the nature of, rosin or wax.

EQUILIBRIUM—from the Latin *equus*, equal, and *libra*, a weight or balance; any thing held in equal balance or counterpoise is said to be in equilibrium. Two bodies, one possessing more electricity than the other, are not in equilibrium; but when the one gives off half of its surplus, so that both have the same quantity, they are then said to be in equilibrium.

TELEGRAPH—from the Greek *tele*, far off, and *grapho*, I write. Inventions which describe occurrences at a distance are telegraphs. Electric telegraphs have been found to convey signals at the rate of 120,000 miles per second; so that were a line of wire laid around the globe, the electric fluid would traverse it in about one-sixth of a second!

LOADSTONE or LODESTONE—from the Saxon *lædan*, to lead; so called from other pieces of iron being led or attracted towards it, or from its always leading or pointing towards the North Pole.

THE ATMOSPHERE.

THE earth is entirely surrounded by a fluid, which we usually call the *air*, but which is termed by men of science the *atmosphere*. This fluid is so thin and clear, that it appears to possess no substance whatever; yet it is as truly a substantial fluid as water. We feel its resistance when we move rapidly through it; and we experience its effects when it flows in violent currents, producing winds and tempests. It is supposed to extend no higher than

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163. In how many ways may electricity be produced?
164. What of the atmosphere, its height and density?

forty-five miles above the earth's surface, always becoming rarer the greater the elevation. This difference in density is produced by pressure, that portion of the atmosphere near the ground being pressed down or made denser by the weight of the parts above it, just as the lower parts of a hay-stack will be rendered closer and denser by the pressure of the parts above.

The atmosphere, as found near the earth's surface, is composed of various gases, in the proportion of one part of the gas called *oxygen* to four of *nitrogen*, along with a very small portion of *carbonic acid gas*. Thus composed, but in no other proportions, it is fitted for sustaining animals, by being inhaled into their lungs; and vegetables, by being absorbed through small pores. It is chiefly the part called oxygen which is used by animals in breathing. Oxygen, entering by the mouth into the lungs, communicates a quality to the blood, without which life soon ceases. Uniting chemically with the carbon in the blood, carbonic acid gas is formed, and thrown back with our expired breath. The heat of our bodies is generally understood to arise from this chemical process. If we continue to breathe in a small and confined place, we in no long time exhaust the air of its more useful ingredient, and overcharge it with carbonic acid gas, which is unfavourable to life and health. This is the reason why it is not proper to keep our rooms constantly close: all rooms, churches, and other such places, where people meet in small or large numbers, ought to be frequently opened to admit fresh air. It might be supposed that the breathing of so many animals would soon render the whole atmosphere unhealthy; but, by a wonderful provision, vegetables retain chiefly those parts which animals refuse, and by the action of the sun's light, exhale or give out the oxygen, so that a constant balance is preserved, and the air is kept from age to age in one constant state of freshness.

The air is necessary for several other purposes. Were

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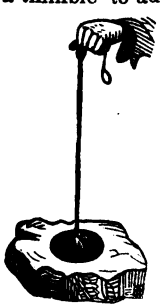
165. Of what gases is it composed?
166. How does it sustain both animals and vegetables?

it not for this fluid, light would produce none of those colours which so much please our eyes in natural objects. The world would not only be without hue, but without sound, for sound is produced by percussions or strokes upon the air, throwing it into a peculiar agitation, so as to affect the membrane of the ear, and thus convey an impression to the brain. Air, being a substance, necessarily possesses gravity or weight. One hundred cubic inches have been found to weigh about thirty-one grains; and upon every square inch of every substance on earth, the whole mass is found to press with a weight equal to fifteen pounds. Thus, an ordinary sized man, with a body of about two thousand square inches of surface, is pressed on every side by an atmosphere equal to about fourteen tons, which is the weight of fully twenty ordinary cart-loads. Now, it happens, that, so far from this being burdensome, it is agreeable and necessary, for the juices of the body have a tendency to swell, which this pressure is exactly sufficient to counteract. Were we in any place from which the air was withdrawn, we should immediately expand in every vein, till our body would fly into pieces.

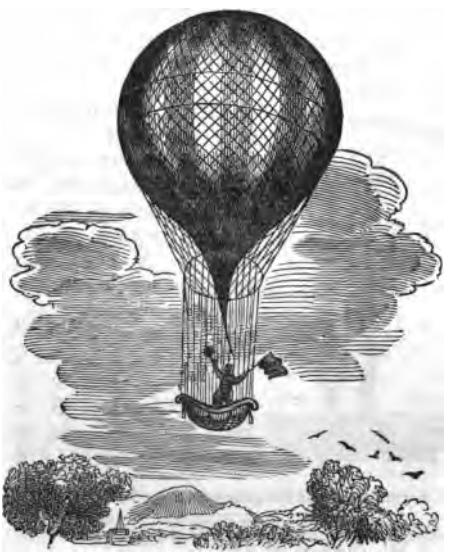
There are many familiar examples of this pressure around us. One of the most common consists in causing a thimble to adhere to the hand by sucking the air from beneath it: the adhesion is the result of the pressure of the atmosphere on the exhausted space on the hand. Another consists in lifting a stone by means of a sucker, formed of a string and a wetted piece of leather, as in the accompanying figure. The wetted leather is in this case pressed down upon the stone, and the string is then pulled: if the air were admitted under the end of the string, the sucker would come off; but none being admitted, a rigid pressure to the stone is produced, and the stone, if not too heavy, is lifted. Any



167. Describe the various uses of the atmosphere.
168. What of its pressure?
169. What illustrations are cited?

boy will readily understand, that if the atmosphere press with a weight equal to 15 lbs. upon every square inch, a square inch of leather will be pressed both upon the upper and under surface by the same weight. But if the atmosphere be excluded from the under surface, as in the case of the sucker, then it must press upon the stone instead; and hence the stone and sucker will be kept together by a pressure equal to 15 lbs.

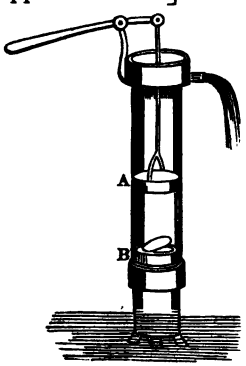
As any substance which is lighter than the same bulk of water will rise through that fluid to the surface, and there float; so any substance lighter than the same bulk of air rises through the atmosphere, until it attains a height where the weight of both is equal. [The common experiment of blowing soap bubbles with a pipe is an easy illustration of this principle.] Thus, if we fill a thin silken bag with the gas called *hydrogen*, which is much



170. How is the ascent of balloons explained?

lighter than common air, it will ascend into the air, provided that the bag and the hydrogen together do not weigh more than the quantity of common air which the bag displaces. This principle has been taken advantage of for the construction of what are called *balloons*—namely, large bags of hydrogen or of common gas, with a car attached below, in which one or more persons can ascend many thousand feet above the surface of the ground, and, driven by the wind, travel to a great distance with extraordinary rapidity. All that is necessary is, that the machine, and the substances connected with it, including the travellers and the contained gas, should not be heavier than the quantity of common air which would in natural circumstances occupy the place of the inflated bag.

[For the ascent of a balloon alone, simply rarefying the air it contains by heat will suffice. A lighted taper applied to the mouth of an inflated bag of any light material will cause it to ascend, by expanding common air until it is but little heavier than hydrogen gas. The latter, however, is inflammable, and will not allow of the approach of fire.]



Water is a denser fluid than air; and hence a column of water, 32 feet in height, has been found to weigh the same as an equal column of the whole atmosphere, which is 45 miles in height. A knowledge of this fact has led to many important contrivances; one of the most familiar of which is the raising of water by means of the pump, which can only be done when the lower valve (B) is not more than 32 feet above the surface of the water.* One of the

* The action of the pump may be here explained.

171. What of the density of water?
172. Explain the common pump.

metals, mercury or quicksilver, which in ordinary temperatures is fluid, is much denser than water; and hence a column of it, only 30 inches in height, is of the same weight as an equal column of the whole atmosphere. Observing this fact, and further perceiving that the weight of the atmosphere differed according to the quantity of moisture it contained, and also on the approach of storms, men of science have formed an instrument called the *barometer*, in which the rising and falling of a column of this metal contained in a glass tube, as the atmosphere chances to become lighter or heavier, betokens the condition of the air for a great distance around, and foretells what will be the nature of the weather for some time to come.

It is only within one or two miles above the level of the sea that the chief beneficial uses of the atmosphere are experienced. It is there of sufficient density to sustain animal life with comfort, to communicate sound, and to aid in the diffusion of heat. Near the level of the sea, water boils under a heat indicated by 212 degrees of Fahrenheit's thermometer; but at the top of Mont Blanc, a hill nearly three miles high, the same fluid boils at 189, or 23 degrees of less heat. This phenomenon is produced by the greater weight which the atmosphere exerts on the surface of the water near the sea, than at great elevations.

BAROMETER—*baros*, heavy, and *metron*, a measure—an instrument devised for ascertaining or measuring the weight of the atmosphere.

WINDS.

Wind is the air in a state of motion. By waving the hand rapidly, or blowing our breath strongly, we may form a movement or agitation of the air on a small scale. Winds in nature originate from a variety of causes. When the air at any particular place becomes heated or rarefied, it ascends because of its greater lightness, leaving a va-

173. What of the density of quicksilver?
174. Explain the barometer.
175. What difference in the atmosphere upon mountains?
176. Explain the phenomenon of winds.

cancy which the colder air of neighbouring regions rushes in to supply. This is considered as one of the chief causes of winds. An exactly similar process may be observed going on, if we throw open the door of a room in which there has for some time been a good fire. If we hold a lighted candle near the top of the open door-way, the flame will be blown outwards; if near the bottom, inwards. In the one case the flame is blown by the heated air going out, and in the other by the cold air coming in to supply its place. The great and continual heating of the air in particular parts of the tropical regions by the sun, and its consequent rising into higher altitudes, cause a constant rushing of air from all neighbouring parts towards those places. Hence, in that part of the earth, there are winds which blow for months at a time from east to west: they are called *trade-winds*, because mariners who have occasion to sail on the Atlantic and Pacific Oceans take advantage of them in their voyages. The winds are of use in dispersing the clouds over the surface of the earth; in purifying the atmosphere from noxious vapours and effluvia; in dispersing the seeds of plants; in impelling vessels over the surface of the sea; and in moving various sorts of machinery.

Besides the trade-winds, there are several others of a peculiar and interesting character. These are the *monsoons*, which are merely the trade-winds turned to the south or north by portions of the land lying within the tropics; the *simoom*, a burning pestilential blast, which rushes with fury over the sandy deserts of Arabia; the *harmattan*, a cold dry wind, which is frequent in Africa and other eastern countries; the *sirocco*, a hot, moist, and relaxing wind, which visits Italy from the opposite shores of the Mediterranean; the *bize*, a cold frosty wind, which descends from snow-covered mountains like the Alps; and *hurricanes*, *whirlwinds* or *tornados*, which are common to all countries, but most destructive in warm regions. In China these are called *typhons*.

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177. What of trade-winds, and other italicised terms?

VAPOURS—CLOUDS—RAIN.

The atmosphere has the power of absorbing into its own body particles of water, and holding them in a state of solution. The process of absorbing water in this manner, which is greatly assisted by the heat of the sun, is called *evaporation*. Over the whole earth, evaporation, to a lesser or greater extent, is constantly going on. The ocean, lakes, rivers, and fields, are ever yielding up water in this invisible form to the atmosphere; and plants and vegetables, as well as living creatures, are also, at all times, giving forth moist exhalations.

The atmosphere is thus a great receptacle for the moisture of the earth. When the temperature of the air is high—that is, when the weather is warm—moisture in the atmosphere is not generally perceptible near the ground. But when the temperature is low, the air is felt to be damp or humid, in which condition it is unwholesome. Sometimes the humidity becomes so great, that the watery particles in the atmosphere are observable in the form of *mist* or *fog*. At night, when the plants lose the heat which they have acquired during the day, the moisture of the atmosphere is condensed upon them in the shape of *dew*.

When watery vapours are carried high into the atmosphere, they receive the name of *clouds*, for clouds are only vapours, whatever be their form or colour. Clouds of a light fleecy appearance have only a little water hanging in them, or hold only a small quantity in solution. When the clouds are dark and gloomy, they are overloaded with water, and ready to be dissolved in showers. Clouds, however, do not part with the water with which they are charged, until they come into contact with a stream or mass of air much colder than themselves. The cold mass of air, in such a case, abstracts from the cloud the heat by which the water is held in solution; the particles of vapour immediately coalesce or draw together,

178. What of evaporation, mist, fog, dew, &c.
179. Explain the formation of clouds, rain, &c.

and form a mass of water, which, being too heavy to be sustained by the atmosphere, descends to the earth, broken into drops of *rain*. Rain is thus a natural consequence of a depression or lowering of the temperature of the atmosphere: again, when the temperature rises, rain ceases, the clouds rise, and perhaps vanish, and beautiful clear weather follows.

Clouds have two distinct uses: first, they serve the purpose of shade against the sun's rays, and so prevent his heat from scorching up the produce of the earth; and, second, they act as reservoirs of moisture to refresh the ground and strengthen vegetation. Clouds thus restore to the earth, in useful rains, the moisture which has been carried off in the process of evaporation. [Rain is generally more abundant, the nearer you approach the equator.]

Evaporation takes place by artificial, as well as by natural means. If heat or fire be applied to a vessel containing water, the water will gradually fly off in steam or vapour. The force with which steam flies off from boiling water is very great; and this force or power is rendered serviceable in moving that powerful machine, the steam-engine.

The phenomena of winds, clouds, rain, evaporation, thunder, meteors, and all other things remarkable in the atmosphere, form the subject of the science of METEOROLOGY.

METEOROLOGY—from the Greek *meteora*, a meteor, and *logos*, a discourse—the science which discourses or treats of those atmospheric phenomena called meteors. Meteors are of three sorts—1. *Luminous*, or *fiery*, such as rainbows, falling stars, lightning, &c.; 2. *Airy*, such as winds, hurricanes, and tempests; 3. *Aqueous*, such as mists, fogs, rain, snow, waterspouts, &c.

WATER.

Water is one of the most abundant and generally diffused bodies in nature. Though appearing in the form of a liquid substance, it is, in reality, composed of two gases, hydrogen and oxygen, in the proportion of one part

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180. What are the uses of clouds?
81. What of artificial evaporation?

of the former to eight of the latter. Its particles or atoms are so slightly united with each other, that the whole mass is said to *flow* easily, and to adapt itself to the shape of the interior of any vessel into which it is admitted. This property belongs more or less to all fluids or liquids, and hence *they press equally in all directions*, while solids press only in one direction, or downwards. A remarkable property in water, arising from this uniformity of pressure, is its rising to the same surface-level in all parts of its volume. For example, if we fill a tea-pot with water, we shall find that the fluid has risen in the spout to precisely the same height as in the pot, and that the small column of water in the spout balances, or cannot be pushed out or over by, the volume of water in the pot. These simple truths were not known to the ancients, who constructed long level canals, resembling rivers, for bringing supplies of water into their towns. In modern times, water is conveyed to great distances through close pipes from springs and fountains. These pipes are laid beneath the surface of the ground, along the risings and fallings of the country, yet they convey the water, without difficulty, to any height which is not above the level of the fountain whence the water has flowed. It is in this manner that most large towns are now supplied with water. [In case the source or fountain is not so high as it is desirable to convey the stream, reservoirs are constructed sufficiently high, and the water is artificially raised by machinery until these are filled. Thus it is, that the Fairmount water-works at Philadelphia are constructed.]

The easy motion of water in all its parts causes it to flow, and hence we have springs, rivers, currents, and other phenomena of running water. It also allows it to be easily agitated, and hence the waves, tides, and other agitations of the ocean. The force of running water has been of essential service to man in all ages, and is still one of the cheapest and most prevalent of moving powers applied to machinery.

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182. The composition of water and its pressure.
183. What illustrations are cited?

Water buoys up any object on its surface which is lighter than itself, bulk for bulk. Any object, also, on being plunged into water, weighs lighter in the water than it would weigh in the air, because it is partially supported by the liquid on all sides. A block of stone is as much lighter under water as the weight of the water which would otherwise occupy its place amounts to; thence such blocks are much more easily moved below the surface of water than above it.

The department of science which relates to the power of water, whether it acts by pressure or by impulse, is called HYDRODYNAMICS. This science is generally divided into two branches—*hydrostatics*, relating to the pressure of fluids; and *hydraulics*, relating to their motion, together with the machines with which that motion is concerned.

HYDRODYNAMICS—from the Greek *hydor*, water, and *dynamis*, power—the science which treats of the power or force of water.

HYDROSTATICS—*hydor*, and *status*, a standing—the science which relates to the pressure or weight of standing water.

HYDRAULICS—*hydor*, and *aulos*, a pipe or channel; hence it is the science of running water, or water moving in pipes or channels. Water-wheels, pumps, syphons, and other mechanical contrivances connected with the motion of water, are treated of under this branch.

ELEMENTS OF MATTER—THEIR COMBINATIONS.

The material world immediately under our observation, including such parts of the earth's crust as have been explored, the plants and animals upon the earth, and the atmosphere which envelopes it, is found to consist of fifty-four substances, just as all the words which compose a language are resolvable into a few letters. These substances, having hitherto resisted all endeavours to divide or resolve them into any others, are termed the *elements of matter*, or *simple bodies*. [We are not authorized absolutely to assert that all these are simple bodies or elements, but only that they have not yet been decomposed. Several of them are even now suspected to be compounds.] But these simple bodies are rarely found

184. Define the technicals on this page.
185. What are the elements or simple bodies?

by themselves in nature. They are generally combined with each other, two by two, or three or more together, and it requires some trouble to separate them. This compound state of matter shows very clearly that the world must have been created by an Intelligent Being, who designed every thing with the greatest care, and fitted all things for each other. In some of the substances of the material world, old combinations are constantly in the course of being undone, and new ones made up: the rotting of one substance and the growing of another out of it is an example; so is the nourishment of the body by food; so, also, is the change effected in our lungs upon the air which we are every moment breathing.

The investigation of the laws under which the fifty-four simple bodies have formed the numerous compound substances which we see in nature, and the means by which compound substances can be resolved into their original elements, or thrown into new combinations, are the objects of the science of CHEMISTRY, the full importance of which has only been brought to light by the discoveries and experience of recent times.

Five of the elementary bodies are *gases*, by which is meant, as nearly as common language can express it, fluids in the form of air. Their names are Oxygen, Hydrogen, Nitrogen, Chlorine, and Fluorine; but the three first are by many degrees the most important. It has already been mentioned that hydrogen and oxygen form water, and that nitrogen and oxygen are nearly the sole ingredients in atmospheric air.

Forty-two of the simple bodies are *metals*, fourteen of which have long been more or less known and used; namely, Gold, Silver, Mercury, Lead, Copper, Zinc, Iron, Tin, Bismuth, Cobalt, Nickel, Manganese, Antimony, and Arsenic. Other fifteen are of more modern discovery, and, from their scarcity and other causes, have been applied to few important purposes. These are, Platinum, Rhodium, Palladium, Iridium, Osmium, Cadmium, Tellu-

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186. Their number and importance.
187. How many are gases, and how many are metals?

rium, Selenium, Chromium, Vanadium, Uranium, Molybdenum, Tungsten, Columbium, and Titanium.

The remaining thirteen metals were discovered in the present century, as the bases or fundamental constituents of substances which formerly appeared only under a compound character. Of the thirteen, eleven had appeared to be what are called *earths*, and two what are called *alkalies*—terms to be afterwards explained. On these earths and alkalies being found to be fundamentally metals, their names were respectively conferred on the metals, with the distinction of a termination in *um*. Thus, the eleven earth-composing metals were styled Aluminum, Glucinum, Yttrium, Cerium, Zirconium, Thorium, Calcium, Magnesium, Lithium, Barium, and Strontium; while the two alkali-composing metals were denominated Potassium and Sodium.

The remaining simple bodies found in nature are reducible under no fixed class. They are named Carbon, Boron, Phosphorus, Sulphur, Silicon, Iodine, and Bromine.

The chemical characters of the elemental substances chiefly bear reference to their combinations. Five—oxygen, hydrogen, chlorine, fluorine, and iodine—appear to have the power of combining with all others; oxygen possesses this property in a very conspicuous degree, and does in reality form a part of almost all substances found in nature. These five bodies are usually styled, from another general feature of their character, *supporters of combustion*.

Nineteen of the other simple bodies—hydrogen, nitrogen, antimony, arsenic, tellurium, selenium, chromium, vanadium, uranium, molybdenum, tungsten, columbium, titanium, carbon, boron, phosphorus, sulphur, silicon, and bromine—when combined with any of the five supporters of combustion, form the important class of compound substances termed *Acids*. These nineteen are thence denominated *Acidifiable Bases*, though they have the power of forming other combinations.

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188. Enumerate them all.
189. What other simple bodies are named?
190. Which are supporters of combustion.

The remaining thirty-one simple bodies, when combined with any of the supporters of combustion, form compound substances, which, by combination with the acids, produce the class of doubly-compound substances, called in chemical phraseology *Salts*.

The first step taken by nature towards the forming of other and more intricate combinations, is the union of two simple bodies. Oxygen is the great agent which joins with and prepares the other simple substances for further associations; and many of them, such as the metals, form scarcely any compounds till they have been united to oxygen—in other words, formed into an *oxide*. The rust of common iron is an example of a metallic oxide, being a compound of particles of the metal with particles of oxygen drawn from water or damp. Another metallic oxide may be easily produced by shaking quicksilver or mercury for a short time in an open phial; the dull scum-like substance which is then observed upon the surface of the fluid metal is an oxide, formed by the union of particles of the mercury with particles of oxygen drawn from the air. This compound substance, then, called oxide, is a preliminary to most other combinations. The first compounds of the gas chlorine are in like manner termed *chlorides*; common salt is chloride of sodium. The similar combinations formed by the other three supporters of combustion do not occur to any considerable extent in nature.

Eleven of the metallic simple bodies, as already mentioned, are the bases of substances called *Earths*. It is by combination with oxygen that they form earths; and in nature they are never found but in this combination. The names of the earths are alumina, glucina, yttria, cerite, zircon, thorina, calx (Latin for *lime*), magnesia, lithia, barytes, and strontytes; from which words, as already stated, the names of the metallic bases were formed by the termination *um*. The general characters of the earths are, insolubility in water, and the power of forming salts with the acids. They are brittle, whitish, tasteless,

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191. Name the acids, and bases;—and the salts.
192. Define oxide, chloride, and the earths.

and very little liable to be affected by heat. Five of them—magnesia, lime, barytes, strontytes, and lithia—are termed Alkaline Earths, from their possessing some of the characters peculiar to the alkalies. The earths alumina and lime form a very extensive portion of the crust of the earth. The vast lime-beds, which have been described, in another part of this work, as composing so much of the Secondary Formation, are (chemically speaking) *carbonates of lime;* in ordinary language, the earth lime, which is a compound of the simple body calcium with oxygen, is here recombined with a certain proportion of carbonic acid (acid formed by the union of the simple body carbon with oxygen), so as to compose what is called carbonate of lime. This ultimate combination falls under the class of doubly-compound substances chemically called *Salts.*

Potassium and sodium, which, like the preceding eleven, are never found in nature in their simple state, constitute, in combination with oxygen, the well-known substances potash and soda, which bear, in chemical language, the appellation of *Pure Alkalies.* The word alkali was originally employed by the people of Arabia to designate an Egyptian plant, the ashes of which had a salt and acrid taste. It has since been employed to describe the two above compound bodies, along with a third named *Ammonia,* which is a gas compounded of hydrogen and nitrogen, extracted from soot and decayed animal matter. The two first alkalies abound in the mineral and vegetable kingdoms. They have a powerful effect in washing clothes, from their readiness in uniting with any unctuous matter; but for this purpose soap, which is a compound of soda and tallow, is now more generally used. The third pure alkali, ammonia, being an impalpable gas, requires to be mixed with water in order to be used. It then becomes the well-known scent called hartshorn. In its gaseous state, it is familiar to our sense of smell, being the predominant odour in newly-cleaned stables. The principal properties of the pure alkalies are, solubility in water, the power of changing vegetable blue to green,

193. Enumerate the earths, and their characters.
194. What of the alkalies?

and the power of uniting with acids to form what are termed *Neutral Salts*. It has already been said that thirty-one of the elemental bodies possess the power of forming salts in combination with acids. Hence these thirty-one simple bodies are said to possess an *alkaline property*, and to be *Alkalifiable Bases*.

It is worthy of remark, that some of the thirteen metals which form the bases of the eleven earths and two alkalies are *inflammable* by contact with *water*. Thus, if a piece of sodium, before it becomes tarnished or oxidized by the air, be dropped upon water, it instantly ignites, and burns with a brilliant flame. This is caused by the rapid absorption of oxygen from the water, which oxidizes the sodium, and forms soda, in the form of a white powder, at the bottom of the vessel.

It has now been seen, that, of the primary combinations, some are formed by the union of oxygen with certain metals, and termed *oxides;* others by the union of oxygen with certain other metals, and termed *earths:* and some by the union of oxygen with two metals, and termed *pure alkalies*. It has also been seen that oxygen, and four other simple bodies, in combination with eighteen of the other simple bodies, of which two are gases, produce *acids*. These last compound substances derive their name from their sour taste. Oxygen is almost the only one of the five supporters of combustion which forms the acids: it was long considered as the sole acidifying principle. Acids have the power of changing vegetable blues to red. They form salts with the alkalies, earths, and the metallic oxides. The name given to an acid indicates its base; and where a base with oxygen forms two different acids, the one with the greater proportion of oxygen is distinguished by the termination *ic*, and the other by the syllable *ous;* as, for example, sulphuric and sulphurous acids. The salts formed with the sulphuric acids are termed sulphates, and those of the other sulphites; which terminations distinguish other salts in similar cases. [The new nomenclature here indicated has this merit, that the name of

195. Define neutral salts.
196. What is the merit of the new nomenclature?

every acid and salt indicates its nature and composition.] The principal substances of this class are the sulphuric, sulphurous, nitric, nitrous, muriatic, iodic, boracic, acetic, tartaric, oxalic, citric, and benzoic acids; those formed with the other acidifiable bases being generally of minor importance. The last five of these acids are called vegetable, and have more than two ingredients. The muriatic is an example of an acid devoid of oxygen, its components being chlorine and hydrogen.

The *Salts*, arising from the combination in definite proportions of acids with alkalies, earths, and other metallic oxides, are very numerous, and are found everywhere in nature. In a state of solution, they constitute a great portion of the weight or bulk of the ocean; incorporated with minerals, or in a pure state, they form no mean part of the earth's crust; and in a condition which is not perfectly understood, they exist in abundance in the vegetable world. As the acids and the metallic oxides, which compose the great proportion of salts, are each compounds with two ingredients, so, of course, the salts contain four ingredients, or, more properly speaking, three, since oxygen is generally both in the acid and the base. It is impossible in this place to give any account of individual salts, but the principal are formed by those acids enumerated. Both the acid and the base are indicated in the name of the salt, as sulphate of soda, muriate of iron, and tartrate of potass. [If there be an excess of acid, then it is called a *super*-sulphate, &c., but if the base be in excess, *sub* is prefixed as submuriate, &c.]

The combination of bodies takes place under certain laws. To explain these, it is necessary to premise, that though we can reduce matter to very small portions by repeated divisions and subdivisions, yet it is considered to be ultimately composed of particles or *atoms* so small that they cannot be further divided. The atoms of each kind of matter are supposed to have qualities peculiar to themselves, and to have the power of uniting with the atoms

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197. What of the salts and their designations?
198. What is said of atoms, and proportions?

of other bodies in what is called chemical union. The atoms of one substance will unite more readily with the atoms of one kind of matter than with the atoms of another. They always join with each other in certain fixed proportions; that is to say, the one ingredient is always an even multiple of the smaller, as two to one, three to one, four to one, and so on—never two and a half, three and a half, or four and a half, to one. Bodies, also, combine only in certain proportions as a whole, not in any quantity in which they may be thrown together; and if a greater proportion of one substance be present than is necessary to form a chemical union with another, the surplus remains in its original state. Thus, if a drop of sulphuric acid be put on a slab of limestone, it will only dissolve or unite with a small portion of the lime, and leave the rest untouched; or if a small piece of lime be put into a jar of sulphuric acid, only so much of the acid will unite with the lime as is necessary to dissolve it. This union of bodies with one another in fixed proportions is called the *Atomic Theory*, and was first propounded by Dr. Dalton of Manchester.

Two bodies, uniting together, produce almost always a compound, with properties and a form differing from that of either ingredient. Thus, water results from the combination of two gases, [oxygen and hydrogen.] When two or more compounds are formed by the same ingredients, but in different proportions, these compounds may possess the most opposite properties. Thus, the two gases, oxygen and nitrogen, enter into five combinations with each other, producing nitric acid, nitrous acid, nitric oxide, nitrous oxide, and common air. The first three are virulently poisonous, and the last, strange to say, is the breath of man's life. The assumption of a solid form by a gas, or the conversion of a solid to a gas, by combination with other bodies, and the total change of properties consequent upon such changes, are facts easily demonstrable, and tend to lessen our wonder at the immense variety of

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199. What of the atomic theory?
200. What wonders result from union in different proportions?

objects in nature, arising from a few fundamental constituents.

Whether in the great laboratory of nature, or in the workshop of the chemist, two of the chief agents by which the forms of bodies are changed, and existing combinations broken up, or new ones formed, are *Fluidity* and *Heat*. When two substances are mixed together in a perfectly dry state, no action or union takes place between them, except in a few rare instances; in general, before a union can be effected, they require to be dissolved in a fluid medium, such as water. The water has an equal attraction over its whole bulk for the substance placed in it, and thus divides it into its constituent atoms, which then act readily on the atoms of other bodies brought into contact with them. Substances are said to be *soluble* when water has this attraction for them; and to what extent matter is divided by solution, is shown by the fact, that the ten-millionth particle of a grain can be proved by experiment to exist in a drop of water. Heat, it is well known, expands bodies; and if applied with sufficient force, it changes solids into liquids; that is, *fuses* them, and converts liquids into vapour. The latter process is that formerly described under the term *Evaporation*. To the chemist, the process of evaporation is of great utility, for, by exposing the water which holds any body in solution to the action of heat, the water flies off in vapour, leaving the dissolved substance at the bottom of the vessel employed. From the finely divided state in which a body exists in solution, it might be supposed that the substance thus procured by evaporation would be in the state of a fine powder. This is not the case; *Crystals* of the substance are formed, and, what is more remarkable, the crystals of one body are always of the same form and appearance. Crystallization is one of the most interesting of chemical operations. It is seen extensively in the flakes of snow which fall from the air, and in the beautiful flowery figures which overspread our windows

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201. What of fluidity and heat?
202. Define the italicised terms of this page.

after a frosty night. Salt and sugar are also familiar objects of this kind. A fine specimen of crystallization may be thus produced:—Take a wide-mouthed phial, into which put a drachm of sugar of lead; fill up the phial with water, and shake it to dissolve the powder. From the cork of the phial suspend a small piece of zinc by a thread, so that it may dip into the mixture. In the course of a few hours, the zinc will be found to have attracted the whole of the lead, which will be found hanging by it in the form of an inverted tree, of a very beautiful appearance.

Evaporation, crystallization, and solution, are, however, in some measure, merely modes by which chemical phenomena are exhibited; the great fundamental cause of all the changes of form which bodies undergo, and of the combinations they enter into, is the power of attraction; the same power which keeps the planets revolving in their stated orbits, and is the cause of all the wonders of the heavens. By this power, which chemists call *Affinity*, the particles of a solid or a fluid adhere to each other, and by the same their cohesion is destroyed. Every body possesses an affinity for other bodies in a greater or less degree, and, in proportion to that degree, will its tendency to unite with them be strong or otherwise. When the affinity between two substances is great, they will even break up connections with other bodies, in order to unite with one another. An example may be thus exhibited. Let a solution of tartaric acid and a solution of carbonate of soda be mixed together, and an effervescence immediately ensues. The carbonate of soda is a compound of carbonic acid and soda, which have an affinity for each other; but between the tartaric acid and the soda a still stronger affinity exists; and when the solutions are mixed, the carbonic acid gas is dislodged, and the tartaric acid combines with the soda in its place, forming what is called a tartrate of soda. A series of changes of this kind can easily be produced. Thus, sulphuric acid readily com-

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203. What of affinity?
204. Name the examples cited.

bines with ammonia; if a little lime be added, the sulphuric acid leaves the ammonia and flies to the lime; add soda, and it leaves the lime—potass, and it leaves the soda—strontia, and it leaves the potass—and finally, if the earth baryte be added, it will leave the strontia, and remain in conjunction with the baryte. If two or three compound substances of different properties be added, a scene of confusion at first takes place; but ultimately the ingredients will be found to have united with each other, each remaining in union with that for which it has the strongest affinity. A knowledge of these varying affinities is the means by which the most of the substances found in nature are made available to human use.

This is an exceedingly superficial view of the principles and phenomena of CHEMISTRY. A more minute knowledge of this important science opens up an enlarged view of the great operations of nature, as well as divers useful processes in the arts. It is by chemical action, in connection with heat, light, air, and moisture, that seeds germinate in the soil, that plants grow, and that flowers are decked with various colours and tints. Hence, a knowledge of the principles of chemistry, which regulate these operations, is of the utmost value to the gardener and farmer. [So numerous and valuable are the improvements introduced by this science into the cultivation of the soil, that agricultural chemistry has been elevated into the dignity of a distinct department, and become almost a science of itself.] It is partly by chemical action that the food received into the stomachs of animals is transformed into blood, bone, muscle, fat, hair, and other kinds of animal structure, and a knowledge of these operations is calculated to be beneficial in the regulation of diet, and so keeping the body in a state of health. It is by chemistry that man has been able to extract from minerals and vegetables those valuable substances used in medicine. It is likewise by chemical action that vegetable and mineral dyes are prepared, and their colours fixed in woollen, linen,

205. Importance of Chemistry, its practical uses.

and other kinds of cloth; and it is by the same action that all bleaching and scouring operations are performed. Chemical knowledge assists in extracting the metals from their crude ores, and in compounding and preparing them for the purposes of life. The extraction of carburetted hydrogen gas from coal, for the purpose of lighting streets, houses, and shops, is one of the triumphs of chemistry; and all the arts of life, such as brewing, baking, tanning, dyeing, and bleaching, have been improved by its discoveries.

OXYGEN—from the Greek *oxys*, sour or sharp, and *geno*, I form; so called from its property of forming acids when it unites with certain substances.

HYDROGEN—from *hydor*, water, and *geno*; so called from its possessing the property of forming water when in union with oxygen. Many of the simple substances have likewise obtained their name from some peculiar property which they possess.

ATOM—from the Greek *a*, not, and *temno*, I cut; that is, what cannot be cut down and divided into smaller portions. The ultimate particles of matter are therefore called atoms, and it is the union of the atoms of any two bodies which forms a chemical union. Atoms of oxygen uniting with atoms of iron, form rust or oxide of iron, which is at first an almost imperceptible film on the surface of the iron, because only one film of atoms can come in contact with the oxygen of the air; but as film after film is oxidized, the rust becomes thicker, and forms a crust of a reddish colour, very different in character from either the oxygen or the iron. By expelling the oxygen from rust, it can be reconverted into metallic iron.

CHEMISTRY—from the Greek *chymeia*, which originally signified the art of producing gold and silver. *Chymeia* is supposed to be derived from *chymos*, juice or liquid; a term applicable to the nitric acid, or *the liquid* which has the power of dissolving gold—hence *alchemy*, or the science which attempted to transmute other substances into gold.

THE VEGETABLE CREATION.

Matter, composed, as we have just seen, of fifty-four elementary substances, may be either organic or inorganic. Plants and animals are called *organic*, because they possess a certain regular arrangement of parts or organs, which are designed to perform certain functions: they possess an active principle called life, are supported by nutriment, and exist in generations. Minerals, water, and

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206. Define organic and inorganic.

air, are, on the contrary, *inorganic*, for they have no peculiar structure for the performance of functions. The inorganic world comprehends all the fifty-four elementary substances; but only a few of these have been employed in forming the organic world.

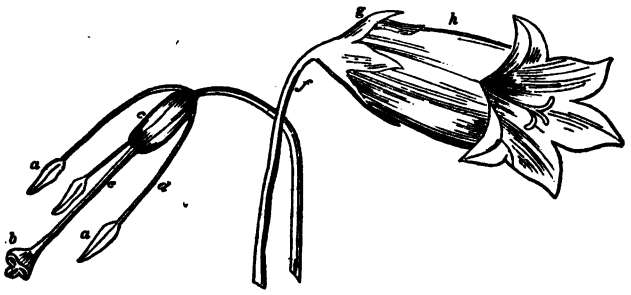
Plants are a department of the organic world possessing structure and functions, with life, and supported by nutriment, but wanting several of the properties of animals. They serve many important purposes in nature, particularly that of supplying food to animals. In this respect they may be considered as a grand step in the economy of nature. Inorganic substances and fluids, in themselves useless, are thrown into the form of vegetables. Vegetables either directly support man himself, or sustain certain animals, whose flesh he eats, and which he turns to many other uses.

Plants require particular soils, and a certain amount of heat, to enable them to grow. Upwards of eighty thousand different kinds have been ascertained to exist. The principal varieties in their size and figure are observable by all who look over the surface of the soil, without any aid from science. We can thus class in our own minds the *moss*, growing upon rocks, or the roof of some old cottage—the *heath* blooming upon the moorland, and the grass overspreading the meadow—the *flower* adorning the field or garden—the *grain* loaded with the food of man—the *shrub* luxuriating in the pleasure-ground—and finally, all the varieties of *trees*, from the slender birch up to the stately elm and oak. But, in a department of nature embracing so many various objects, it has been found necessary to adopt a more particular classification.

One of the peculiarities of vegetables is, that they reproduce each other by means of seeds. Now, it was observed by a great Swedish naturalist, named Linnæus, that varieties existed in the organs or parts by which plants reproduced their own kind. He therefore originated a mode of classifying them with a regard to these varieties. One part of the apparatus by which plants reproduce each other is

207. Number and variety of plants.

termed the *pistil*, marked with the letters *e b* in the accompanying picture of a common flower. Another part is called the *stamen*, of which two are marked in the picture



by the letter *a*. Now, some plants have one stamen, some two, and some a considerable number: some have the stamens in one part of the plant, and some in another; some have them in different flowers from the pistil, and some on the same; while a certain kind, including mosses and sea-weeds, do not show any. Out of these various peculiarities, expressed in the Greek language, Linnæus formed the designations of twenty-four CLASSES of plants, as *Monandria*, having one stamen; *Diandria*, having two stamens; *Gynandria*, having stamens and pistils united; *Crpytogamia*, having no appearance of reproductive apparatus; and so on. Each of these *classes* he divided into various *orders*, with a regard to certain minor peculiarities of the same kind; each of these *orders*, again, he divided into *genera*, with a regard chiefly to peculiarities in the flower; the *genera* were finally divided into *species*, each of which was a particular plant, bearing one constant character. By means of this classification, a naturalist is never at a loss in giving a brief and significant account of any plant that may be presented to his notice. There is another kind of classification, called the Natural System, the inven-

208. Define the italicised terms.

tion of a late French naturalist, named Jussieu. It professes to arrange plants according to the greatest number of peculiarities which they have in common. The first division by this system is into families, according to the forms of the flowers—as *Labiate*, in which the flowers are like the lips of an open mouth (mint and dead-nettle are of this kind); *Cruciform*, in which the flowers consist of four leaves in the form of a cross (of which cabbage, turnips, and wall-flower are examples); *Papilionaceous*, in which the flower is somewhat like a butterfly (pease, beans, and broom, are of this kind); and *Umbellate*, having flowers which radiate from the centre, as the marigold, the poppy, and the hemlock; and so on.

At the bottom of the pistil is placed a cell, usually of an oval shape, called the seed-organ or *ovarium*, on account of its containing the seeds; in the foregoing engraving it is marked by the letter *c*. To these seeds a germinating power is communicated, through the pistil, by a species of dust called *pollen*, which is produced and shed by the stamens. In the plants which have stamens and pistils on the same flower, the pollen is easily shed from the one part to the other, the stamens being, for this purpose, below the pistil in drooping flowers, like that represented in p. 101, and above it in upright flowers, so that the pollen may fall upon the place where it is to perform the office assigned to it. Where some flowers on one plant have stamens, and others pistils, the communication of pollen from the one to the other is not so certain to take place, yet rarely fails. There is greater difficulty when the stamens and pistils are on distinct plants, for these may be at a considerable distance from each other. Nature, however, has made wonderful provision for overcoming this difficulty. The pollen is so light, that the wind readily carries it from flower to flower. In grasses this is generally the mode of fructification. It has also been provided that the flowers give out a sweet liquor, of which bees are fond. The bee, entering to sip this liquor, is dusted with some of the pollen from

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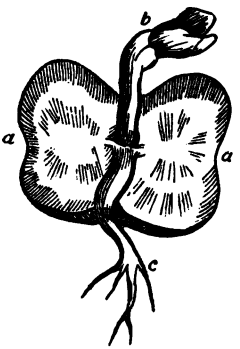
209. State the peculiarities of the natural system.
210. Explain the italicised terms.

these stamens, which it carries to a plant that has only pistils, and thus works out the end which nature has in view. When the seeds in the ovarium have received the germinating power, they advance to maturity, and usually burst the cell in which they are contained. When deposited in the ground, the seed will, in proper circumstances as to air, moisture, and heat, proceed to *spring*. After it has swelled a little, the part commonly called the *eye* of the seed is broken, and a fibre is sent forth at the opening. This quickly divides into two, one of which descends in order to become the root, *c*, while the other, *b*, ascends in order to become the stem of the plant; the seed, *a* (here



cut into two lobes or *cotyledons*), after it has for some little time given sustenance to the fibre, gradually decays. The root serves two purposes—to fix the plant in its position, and to draw up sustenance from the soil, the latter duty being performed more immediately by small spongy excrescences branching from the more solid parts of the root, and which are renewed every year. The seeds of various kinds of plants require different spaces of time for germination; the mustard seed springs in a day; the seed of the rose requires two years.

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211. Describe the process of germination.

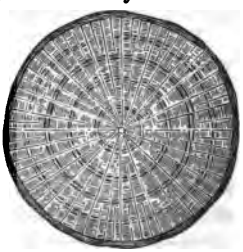
The most common kinds of plants are so familiar to the eye, in all their various parts and aspects, that a minute description of them is not necessary. In the engraving of a bulbous buttercup (see below), *a* is the root, *b* the bulb, *c c* are the root-leaves, *d* is the stem, *e* the stem-leaves, *f* the branches, *g* the flower-stalk, and *h*, the flower. Such are the most of the external parts of a plant which strike the eye of a casual observer. But in flowers there are some minute divisions or parts, which must also be noticed. In the engraving upon page 101, the stamen *a* is supported by what is called a *filament*, marked *d*; *f* is the *peduncle*; while the flower is divided into two portions, the *calix* or *cup*, marked *g*, and the *corolla*, marked *h*. It is

the characteristic of a shrub, that the branches issue directly out of the root. Trees, on the other hand, have roots,

212. Explain the drawing, and technicals.

trunks, branches, and leaves, the branches springing out of the stem, usually at a considerable height above the ground. The stems and branches of trees attain a woody consistency, which fit them for being used as timber. The stalks of corn and reeds are also serviceable to man. But the stems of the most of the lesser plants are of no use, except to return in a decayed state to the soil.

Vegetables derive their support in nearly the same manner as animals, from food and air. From the soil, the spongy ends of the roots take in moisture, containing not only pure water, or the oxygen and hydrogen gases, but also minute quantities of certain earths and salts. A vast number of invisible upright hollow tubes, which pervade the stem and branches, then conduct the moisture, or, as it is more usually called, *sap*, through the body of the plant or tree, till it arrives at the leaves. In daylight, about two-thirds of the oxygen and hydrogen contained in the sap flies off in vapour through multitudes of invisible pores spread over the upper sides of the leaves. The quantity of moisture thus sent forth by plants is surprisingly great; a common sun-flower has been found to exhale thirty ounces in a single day. Similar pores in the under sides are at the same time engaged in inhaling the carbonic acid gas, which forms a small part of the atmosphere, and is receiving constant accessions from the lungs of animals. The sap, thus relieved of so large a portion of the oxygen and hydrogen, and charged with carbonic acid gas, returns, in most plants, along the *exterior* of the branches and stem, immediately under the bark or skin, where it deposits itself in new vegetable matter, so as to add to their thickness. [The accompanying engraving represents a stem of five years old, cut across, having the *pith* (a kind of soft matter) in the centre, and a layer of timber for every year of the growth, spreading in circles towards the outside,



213. Define the italicised terms.

which is covered with bark.] In a few plants, of which the onion, lily, tulip, and palm-tree, are instances, the sap returns along the *interior*, and the increase of substance of course takes place within. In plants of this kind, the seed invariably consists of only one lobe, whence they are called *monocotyledons;* while, in the other, it consists of two, for which reason these are called *dicotyledons*. The process of sap-nourishment only continues during the milder season of the year: at the approach of winter, the rising and falling of the sap ceases, and the leaves, (except in the case of evergreens,) no longer of any service, wither and drop off. When spring returns, new leaves burst from the branches, and the process of sap-nourishment is recommenced.

Light is essential to perfect vegetation. In the night-time, or when planted in a dark place, plants do not give out the hydrogen and oxygen of the ascending sap; on the contrary, they take in oxygen and give out carbonic acid gas. Hence to deprive plants of the light for any length of time renders them unhealthy. It is the carbon that, mingling its dark hues with the yellow of the sap, forms the green colour so prevalent in the vegetable creation, and so refreshing to the eyes of man. In the absence of light, and where plants consequently do not retain carbon, they do not acquire this green colour, but exhibit a degree of paleness, which is not unjustly supposed to be a token of want of health. The exhalation of carbonic acid gas renders it dangerous to sleep in a room where there are many plants, this gas being as destructive to animal, as it is favourable to vegetable life.

The vegetable substances which serve most directly our wants, may be classed under the various heads of Grains, Grasses, Esculent Roots, Plants strictly so called, Fruit Trees, and Timber Trees.

Of *Grains*, (or, as they are called in science, the Cerealia, or Cereal plants,) the chief are wheat, barley, oats, maize or Indian corn, rye, rice, and millet. Several of them are reared in great quantities in most countries:

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214. What of the presence or absence of light?

in 1828, twelve millions of quarters of wheat were calculated to have been raised in England alone. It is remarkable that none of the grains are anywhere found growing in a wild state; the time when they were first cultivated by man, and the means by which he obtained them, are unknown. The seeds, growing abundantly at the top of the stalk, are the parts chiefly serviceable to man. These, being ground into flour, form bread; or, by a process termed fermentation, they can be made to produce various beverages, such as beer, ale, whisky, &c. Beans, pease, and vetch, are called *Leguminous*, or pulse crops; and are also extensively cultivated as articles of food.

The *Grasses* are exceedingly numerous, but the most valuable are those cultivated by the farmer for pasture or for hay. Common pasture is not formed by grasses, strictly so called, but by a sward of herbs and grasses of various kinds. Rye-grass, clover, sainfoin, lucerne, and other plants of a similar description, are those generally cultivated in Britain, and are termed *artificial* grasses, in contradistinction to natural pasture and meadow hay. The straw of the cereal and leguminous crops is also largely used as fodder for horses and cattle.

Of *Esculents*, the potato, turnip, cabbage, carrot, beet-root, parsnip, onion, garlic, arrow-root, and cassava, are the chief, all except the two last being common to most temperate countries. The potato originally grew in Chili, in South America, whence it was imported into Britain and Ireland at the close of the sixteenth century, and afterwards into other European countries, though it was only about the middle of the eighteenth century that its use became common in Britain. The turnip and cabbage were known to the Romans: these, with cauliflower, broccoli, and some of less note, form a family of plants which bear the general name of *Brassica*. By cultivation, the stem and leaves of the cabbage have in time become the most useful for food.

Of *Plants*, strictly so called, one of the most extensively used is the tobacco, which has never been cultivated to any

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215. What of grasses, esculents, and plants?

considerable extent in any other country than the southern parts of the United States of America. This is an annual plant, with leaves of about two feet long, which, when dried, and liquored in a peculiar manner, are used in various ways, all of which are supposed to be rather injurious than beneficial to the health of man. The cotton shrub grows in the same country, and in South America, Egypt, and the East Indies. Its seed-pods contain a fine down, which, in the last-mentioned country has been used for the manufacture of a light and warm kind of cloth since several hundred years before the Christian era, and is now the material of a large portion of the clothing worn throughout the civilized world. Of this down the United States raised, in 1829, nearly nine hundred thousand bales; [and in 1840, exported cotton amounting in value to nearly sixty-four millions of dollars, no less than eighty millions of dollars' worth having been produced in the country during that year.] The flax plant, which grows in Britain and other countries, yields from its skin a well-known filamentous or thread-like substance, which, when dressed, spun, and woven, forms linen cloth. The sugar-cane, supposed to be a native of China, but now cultivated largely in the West India islands, in Brazil, and in other tropical countries, is a plant which grows in the shape of a tapering pole to a height of between six and eighteen feet, with a long and slender leaf springing from each knob or joint, and a bunch of leaves at the top. It is propagated by cuttings, which are planted in rows: at the end of the first season, the full-grown cane is cut by the root, and a new one grows upon the stump next year; it is then necessary to plant a new cutting, as the produce would otherwise be inferior. The cane contains a matter, which is brought out by boiling, and, after undergoing various refining processes, becomes the sugar with which we sweeten tea, coffee, and other articles of food. About five hundred millions of pounds weight are annually consumed in Britain.

A considerable number of *Herbs*, or plants of smaller

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216. What important plants are cultivated in America?

size, are useful to man as food or as medicine. Lettuce, parsley, celery, and asparagus, are well known as agreeable food. Formerly, a great number of herbs were used by physicians; but the most of them have now given way to mineral drugs, which can be administered with greater precision and more certain effect. The dried flowers of chamomile, which grows in the south of England, form a tincture useful for strengthening the stomach, and for producing vomiting. The leaves of senna, a low shrub which grows in Upper Egypt, form an infusion useful as a laxative medicine for children. The seeds of the mustard plant, taken whole, are a good laxative, and, when ground, form a well-known seasoning for food. The pepper plant, of which there are sixty species, the best of which grow in the West Indies, also yields seeds, which are useful both in a whole and ground state for seasoning.

Of *Fruit Trees*, the most remarkable are the vine, date, fig, olive, orange, lemon, peach, plum, cherry, apple, and pear. The first four, which only grow in warm climates, were known in very remote antiquity, and are frequently alluded to in the Bible. The juice of the grape or vine fruit has been employed, from the earliest times on record, in forming wine. For this purpose, immense quantities of the fruit are produced in all the countries bordering upon the Mediterranean, and throughout the South of Europe. The apple, which is also mentioned in the Bible, is now the most prevalent fruit in Britain and the United States of America. Gooseberries, currants, and strawberries, in many hundreds of varieties, are also common fruits in Britain and America. A tree, which originally was confined to the southern parts of Asia, but is now cultivated in the islands of the Pacific and Atlantic Oceans, bears fruit of a large size, the inner part of which, when baken in an oven, resembles bread: this is consequently called the bread-fruit tree.

A few others, which cannot strictly be called fruit trees, are serviceable to man. The cinnamon tree, which is sup-

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217. What of the sugar-cane? herbs, and fruits?

posed to have originally flourished in the island of Ceylon, in the East Indies, is esteemed for its bark, which, when dried in the sun, becomes an agreeable spice. The coffee tree, a native of Arabia, but now cultivated largely in the West Indies, is valued for its seed, which, being scorched and ground, and placed in an infusion of warm water, gives an agreeable beverage. The tea-plant, which grows in a temperate region of China, and appears to thrive nowhere else, yields leaves which, being dried and infused in hot water, give out an equally agreeable beverage. Coffee and tea, as these beverages are respectively called, were not introduced into Europe till the seventeenth century. They now rank among the chief luxuries, or rather necessaries of life, in all civilized countries, no fewer than forty millions of pounds of tea-leaf being annually consumed in Britain alone; and a much greater quantity in America. The hop, a climbing plant, is extensively cultivated in the south of England, on account of its flowers or seed vessels, which impart a bitter but pleasing taste to ale.

Timber Trees abound in almost all countries except those exposed to the greatest degrees of cold. Britain possesses the oak, elm, ash, beech, birch, holly, hawthorn, chestnut, pine, yew, and many others. The oak, which has been known to survive a thousand years, and overspread an acre of ground with its branches, supplies timber of a hard, solid, and durable kind, useful in the construction of ships, and the woodwork of large public buildings. The pine, which grows in its greatest perfection on the hills of the north of Scotland, is also useful in shipbuilding. Britain, on account of the preference long given there to agriculture, does not rear a sufficient quantity of timber for its own use, but imports it from the North American colonies, and the United States, where it grows in great luxuriance. The best kinds of pine timber are produced in Norway. The mahogany tree grows in the West Indies, and in several parts of the American conti-

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218. Name the variety of foreign fruits and plants.
219. What of timber trees?

nent; it sometimes reaches the height of a hundred feet; the timber is peculiarly hard and close-grained, and capable of a high polish, so as to be very suitable for the construction of articles of household furniture.

The Oak.

The science which takes cognisance of the vegetable substances of the earth is named BOTANY. The structure and internal economy of plants fall under a distinct branch of science, termed *Vegetable Physiology*.

VEGETABLE—from the Latin *vego*, I grow; having the power to grow or increase in size, as plants do, and hence specially applied to them.

CEREALIA—from *Ceres*, the heathen goddess, supposed to preside over the culture and growth of grain.

LEGUMINOUS—from the Latin *legumen*, a kind of vetch or pea; a term applied to those plants whose seed is contained in pods, like the pea and bean.

ESCULENTS—from the Latin *esca*, food, or any thing to be eaten; a term applied to those plants and roots which form articles of food.

FILAMENT—from the Latin *filum*, a thread. The thread-like fibre which supports the stamen of a flower is technically called the filament.

PEDUNCLE—from the Latin *pes*, *pedis*, a foot; the footstalk which supports the blossom of any plant.

BOTANY—from the Greek *botane*, grass or plant; hence applied to the science which treats of the nature and varieties of plants.

THE ANIMAL CREATION.

All parts of the earth's surface, except those exposed to intolerable degrees of cold, are peopled by *Animals*—that is, by beings which not only possess an organized structure, as the plants do, and, like them, are capable of being nourished by assimilating various other substances, but are animated by an *internal principle*, which can be traced in many very remarkable results, particularly motion from place to place, a selection of advantageous circumstances, and a power of adapting means to ends. At the head of this class of beings stands *Man*.

Every one has a general idea of animals: we all have seen and know something of quadrupeds, birds, fishes, and insects—for these, in some of their numerous varieties, are daily presented to our eyes. Every considerable portion of the earth is peopled by certain classes of animals, which are either calculated to exist alone in the climate which there prevails, or have been prevented by some other circumstances from spreading beyond it. Besides the many kinds of animals which commonly fall under our notice, there are numberless varieties so small that we cannot see them without the aid of an instrument called a microscope, which is designed to make minute objects visible. Wonderfully careful and ingenious provisions have been made for the support of this vast multitude of visible and invisible creatures, not one of which, however vile or unimportant it may appear to us, has been left without some mark of Almighty wisdom and goodness, either printed upon its form, or shown in its manner of life.

Besides varieties in size, animals are distinguished by various degrees of simplicity in their structure, mode of life, intelligence, and other properties. The very smallest creatures are generally distinguished by the less complication of their parts; but above a size by no means large, neither intricacy of form, nor degrees of intelligence, are observed to depend expressly upon any particular bulk.

The Animal Kingdom, as this department of nature has

220. Difference between plants and animals?
221. What of the variety of animals?

been called, was arranged by Cuvier, an illustrious French naturalist, in four *Divisions*, each distinguished by some broadly marked peculiarity of structure. These divisions he subdivided into *Classes*, marked by peculiarities of less importance; these, again, into *Orders*, with a reference to still less conspicuous distinctions; and these, finally, into *Families* and *Genera* (or kinds). The Cuvierian system, as it is termed, being based entirely on physiology, or internal structure, is apt to appear to uninstructed persons, who only regard the exterior of animals, as not the most natural that might be. But its merits in a scientific point of view are generally acknowledged. In the following outline, besides the Latin names, which are absolutely indispensable for a knowledge of the Animal Kingdom as a system, explanations of the words are given within parentheses.

The four Divisions are VERTEBRATA (Backboned Animals), MOLLUSCA (Soft or Pulpy Animals), ARTICULATA (Jointed Animals), and RADIATA (Rayed or Branched Animals).

The VERTEBRATA include a large proportion of those animals with which we are most familiar, and are subdivided into four *Classes*—*Mammalia* (Suck-giving Animals); *Aves* (Birds); *Reptilia* (Reptiles); and *Pisces* (Fishes). Each of these is again subdivided into *Orders*.

Orang-Outang.

The class MAMMALIA embraces nine orders. The first is *Bimana* (having two hands), an order which embraces but one creature—Man, the most highly endowed of all animated beings. The second *Quadrumana* (having four hands), comprehends Monkeys. These creatures are remarkable for the resemblance they bear to the human race, and for the intelligence which many of them display. They are, however, different in many peculiarities of make from men, so as to show that

222. What of the Cuvierian classification?
223. Name his Divisions and define them.
224. To which does the Mammalia belong?

the one race is quite distinct from the other. The structure of the bodies of monkeys fits them for climbing, and they appear to have been designed to live chiefly amongst the branches of trees. The most remarkable species of monkey is the Orang-Outang, which is nearly as big as a man, and has no tail. Another, called the Chimpansee, an inhabitant of Guinea, in Africa, is considered the most intelligent, as it builds huts of sticks and leaves, and protects itself from the attacks of other creatures with clubs and stones.

The third order is *Carnaria* (butchering or flesh-feeding animals). It embraces three families, the first of which (*Cheiroptera*—hand-winged) comprehends the various kinds of Bats; while the second (*Insectivora*—insect-devourers) includes the Hedgehog, the Shrew, and the Mole. The third family of this order (*Carnivora*—flesh-devourers) is composed of a great variety of important animals, most of which are beasts of prey. The Bear, of which there are many varieties, chiefly living in cold northern countries—the Racoon, an inhabitant of North America—the Badger—the Glutton—and the Ratel, form a tribe called *Plantigrada*, from their setting down the whole foot in walking. Another tribe, named *Digitigrada*, from their walking on the ends of their toes, embraces the Weasel, Polecat, Skunk, Otter, Civet, and Hyæna. To this tribe also belongs the Dog, an animal highly useful to man, and of which there are numberless varieties. Naturalists likewise rank in this portion of the family of flesh-devourers the feline races, comprehending the Lion, Tiger, Jaguar, Panther, Leopard, Puma, Lynx, and Cat. These are called the *feline* races, because the cat (in Latin, felis) is a creature familiar to us, which they all re-

Lion.

225. Define the technicals here.
226. Which is the third order of this class?
227. Name the families belonging to it.

semble. They are remarkable, in structure of body, for union of great strength with great lightness and agility, and for their powerful teeth and claws. These peculiarities, with a stealthy and cunning character, show that they have been designed to subsist by the destruction of smaller animals. The Lion is commonly called the King of Beasts; but he only merits this title from his terrible look and fierce habits, and not from any nobleness of nature. Another tribe of the Carnivora is called *Amphibia* (animals that live either on land or in water), and embraces the various kinds of Seals, the Morse, and the Sea-Lion.

The *Marsupialia* are the fourth order of Mammalia. They are so called from their female having a pouch in front, in which she produces, and afterwards keeps, her young. The Opossum, which lives in North America, and the Kangaroo, which resides in Australia, and sometimes reaches the size of a man, are the chief varieties.

Kangaroo.

The fifth order of Mammalia is the *Rodentia* (Gnawing Animals), comprehending the Squirrel, Marmot, Rat, Mouse, Beaver, Porcupine, Hare, and Guinea Pig. The Rodentia derive their name, as an order, from their being furnished with teeth which do not directly cut or tear, but file through, or gnaw, what they are disposed to eat. The powers of the common mouse in eating its way through hard wood are well known. This order of animals is also remarkable for having long hind legs, which give them a lurching mode of walking. Most of them are afraid of other animals, and live as much as possible in obscure situations. Beavers are the most ingenious of all animals in constructing a dwelling. They cut wood near a stream, and let it float down to a particular place, where they design to use it in building huts. They also erect dams to protect their huts, and in winter live in these places, much like a number of human beings living in a town.

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228. Which is the fourth, fifth and sixth order of Mammalia?
229. Describe each of these.

The *Edentata* (Animals without front teeth) are the sixth order. It embraces a few creatures of comparatively little importance. The sloth, which is the chief variety, is so called from its slow motions, and apparently indolent character. The Armadillo is covered with scales, like an ancient warrior in his armour. The Ant-eater is well known from his habit of laying out his long tongue across a path traversed by ants, till hundreds of them are upon it, when he draws it in, and devours them. Two gigantic varieties of the sloth, the Megatherium and Megalonyx, appear, from the remains of them which have been found in rocks, to have been conspicuous members of the animal kingdom long before man existed.

The seventh order, *Pachydermata*, or thick-skinned Animals, are distinguished from the first six orders by their having no nails or claws, as those orders have, but a single, or at most a double horny mass, termed a hoof, which seems to have been designed simply as a kind of shoe to protect their feet. The Elephant, the largest and most sagacious of living animals, forms one family, distinguished chiefly from the rest by having a long snout, or proboscis, the design of which is to lift food to the animal's mouth.

Elephant.

A second family is composed of the Hippopotamus, or river-horse, the Rhinoceros, the Tapir, and the Boar or Hog—the last being the only animal of this order whose flesh is eaten by man. A third family embraces the Horse, Zebra, and Ass.

The eighth order of Mammalia is the *Ruminantia* (Ruminating Animals), which includes many of the creatures most useful to man, as the Camel, Stag, Antelope, Goat, Sheep, Bullock, and Buffalo. They live on grass, and receive their name as an order from their habit of chewing their food twice, or "chewing the cud." It first descends, in a slightly chewed state, into a large paunch; thence it

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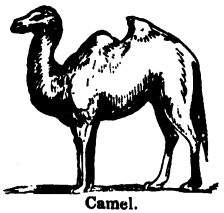
230. What of the seventh and eighth orders?


Camel.

Stag.

passes into a smaller, the inside of which is like a honey-comb, where it is made up into balls or pellets. The animal, lying at its ease, causes these balls to come back into the mouth, to be more effectually chewed. When the food has undergone this last process, it descends into a third stomach, and thence into a fourth, where it is digested. The ruminants of all animals are those most useful to man. They supply him with a large proportion of his animal food, in the form of beef, mutton, venison, &c. Some serve him as beasts of burden; others furnish him with milk, tallow, leather, hair, wool, horn, and other useful products.

The ninth order is the *Cetacea* (Animals partaking of the character of the Whale). They are divided into two families. The *Cetacea Herbivora*, of which the Lamantia is the chief species, are so called because they leave the water to pasture on the herbs growing upon land. The *Cetacea Ordinaria* live in the water alone, but have warm blood, and breathe the atmosphere. The principal species is the Common Whale, the largest of all living creatures. It is sometimes seventy or eighty feet long. It moves

Whale.

through the water by a tail and two paddle-feet. The

231. What families belong to the ninth order?

tail is powerful enough to toss a boat and its crew into the air. The whale is caught for the sake of its blubber, a fatty substance which envelopes its carcass, and which has been known, in some instances, to yield a hundred and twenty tons of oil. The Dolphin, Narwhal, and Cachalot, are other varieties of the Ordinary Cetacea.

AVES (Birds), the second class of the division Vertebrata, are distinguished from the Mammalia by many peculiarities. They first exist in eggs, and are at no time suckled. They are usually covered with feathers, and, along with one pair of limbs and feet, have wings, by which most of them are enabled to fly. The first order, *Accipitres* (Rapacious, or Seizing Birds), are distinguished by hooked bills and strong claws. Like the Carnaria among quadrupeds, they live entirely upon flesh, usually preying upon birds weaker than themselves. The Vulture, Eagle, Falcon, Hawk, and Owl, are the most remarkable families of this order. The eagle, from his great size, strength, and fierce character, has been called the King of Birds.

Eagle.

The *Passerinæ* (birds partaking of the character of the Sparrow) form the second order, which includes the Sparrow itself, the Thrush, Swallow, Nightingale, Lark, Bullfinch, Pie, Crow, and many others of the more familiar and smaller birds. The Passerinæ chiefly live upon grain and insects; some possess wonderful powers of song. Among them are found two families remarkable for the beauty of their plumage—the Bird of Paradise, a native of New Guinea, and the Humming Bird, which is also an inhabitant of tropical countries, and regarded as the smallest of all the feathered tribes, some varieties being not larger than a mountain bee.

The third order, *Scansores* (Climbing birds), embraces the Parrot, the Woodpecker, and the Cuckoo. The first is remarkable for its power of imitating the human voice.

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232. How are the second class of animals distinguished?
233. Describe the first, second, and third orders of birds.

The *Gallinaceæ* (birds partaking of the nature of the common domestic Cock) form the fourth, and a very important order. Besides the Cock, and his well-known and useful companion the Common Hen, it embraces the Peacock, Turkey, Guinea-fowl, Pheasant, Grouse, Partridge, Quail, and the numerous varieties of the Pigeon. In this order are found the chief birds used for food, and most of those which are considered as *Game Birds.*

Pheasant.

The fifth order, *Grallatoriæ* (Wading Birds), includes the Ostrich, Cassowary, Lapwing, Stork, Heron, Crane, Pelican, Snipe, Stilt, and others, all of which are remarkable for having long unfeathered legs, designed for enabling them to walk into shallow waters, there to catch their prey. They usually have long bills also, with which they search the waters for fish and reptiles. The ostrich, which abounds in Arabia and Africa, is the largest of all birds: it reaches a height of eight feet, and lays an egg three pounds in weight. The ostrich and cassowary are remarkable for the hairy-like appearance of their feathers, their long necks and limbs, and their defenceless and awkward-looking figures.

Black-winged Stilt.

The Duck, Goose, Swan, Teal, Sea-gull, Penguin, Albatross, and Petrel, are the chief varieties of the *Palmipedes*, which constitute the sixth and last order. These birds derive their name, as an order, from a membrane extending between their toes, by which they are enabled to paddle themselves along through

Teal.

234. Describe the fifth and sixth orders.

the water. In common language, they are *web-footed.* An oil exudes from their bodies, and, overspreading their feathers, makes it impossible for any wet to penetrate to their skin. They are thus enabled to float upon the water, and dive beneath it in search of food, without injury. The swan, as it floats along a smooth lake, is considered as one of the most beautiful of birds; but it has not been designed to walk with equal grace upon the land. The petrel is a sea bird, and is usually seen only in stormy weather.

The Reptilia (Reptiles), forming the third class of vertebrated animals, are distinguished by a slow mode of respiration, which causes their bodies to be colder and more inactive than those of the Mammals and Birds. Many of them are also without limbs; and hence the name reptiles, or creepers. They at first exist in the form of eggs.

There are four orders in this class. The *Chelonia*, or Tortoises, are enveloped in a hard shell, from which no part projects but the head, tail, and four feet. They chiefly inhabit warm countries. One kind, the Turtle, is a delicious food in the form of soup. Tortoises are remarkably tenacious of life, subsisting for years without food, and even surviving for weeks after the head is cut off.

Tortoise.

The *Sauria*, the second order, are creatures of the character of the Lizard. They have long bodies with feet,

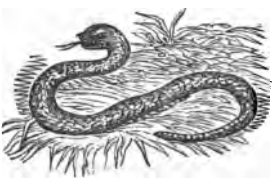
Crocodile.

and a long tail. The Crocodile and Alligator are large and powerful animals, haunting rivers and swamps in warm countries, and often making even man their prey. The Lizard Proper is a comparatively small and harmless ani-

235. What distinguishes the third class of animals?

mal. The Iguana, a native of South America, resembles the alligator in size, but is used as food. With this family is classed the Dragon, which, instead of being a large, fierce, and winged animal, as represented by ancient writers, is a small innocent creature, possessing only a membrane like that of a bat, which enables it to make long leaps. The Chameleon is another member of this order, having the power of changing its colour, about which so many stories have been told by travellers. It is a small creature, which lives upon flies. Reptiles of the Saurian order, but of kinds which do not now exist, have already been described under another section as amongst the earliest animals which were fitted to live upon dry land.

The third order, *Ophidia*, embraces many kinds of serpents, snakes, and vipers. These are the only vertebrated animals which do not possess legs; their bodies consist of a great number of vertebræ and ribs, and by contractions of these, they move in any direction they please. Many creatures of this order have poisonous teeth, which render them very noxious to man. The common viper of this country is comparatively a small creature; but in warm countries there are serpents, such as the *boa constrictor*, thirty or forty feet in length, capable of killing and eating deer, and even oxen.



Viper.

The *Batrachia*, constituting the fourth order of Reptiles, are creatures of the character of the Common Frog. To this order belong, besides the various kinds of frogs, the Toad, the Salamander, and the Siren. They are remarkable for possessing, at an early stage of existence, lungs resembling those of fishes, which enable them to live in the water. Young frogs are then called tadpoles. What

Frog.

236. Describe the first, second, and third orders.

is more surprising, when the frog ceases to be a tadpole, and begins to live on land it acquires another kind of lungs, suitable to its new condition.

The class PISCES (Fishes) are fitted, by structure and mode of respiration, for inhabiting the waters. They are divided into five orders—*Acanthopterygii* (thorny-finned), including the Perch, Flying-fish, King-fisher, Mackarel, Sword-fish, Mullet, and others; *Malacopterygii* (soft-finned), including the Carp, Pike, Cat-fish, Trout or Salmon, Cod, Haddock, Ling, flat fish of all kinds, and all fishes of the eel kind; *Lopobranchii* (having tufted gills), including the Pike fish and Pegasus; *Plectognathi* (having cheeks united by suture), including the Sun-fish and Trunk-fish; and *Chondropterygii* (having cartilaginous fins), including the Shark, Ray, and Sturgeon. Fishes are a class of creatures of great utility to man, furnishing him with abundant supplies of agreeable food. Some kinds inhabit the salt water exclusively, others the fresh; and the salmon is remarkable for leaving the ocean, its usual residence, at a particular time of the year, and proceeding up the rivers, in order to propagate its kind. Fishes propagate their kind by egg-like bodies called roe, and the process of depositing the roe is called spawning. They are of all sizes, from the minute par of our rivers, up to the tunny-fish, a native of the Mediterranean sea, which measures from fifteen to eighteen feet in length.

Salmon.

The MOLLUSCA (pulpy animals), which form the Second Division of the Animal Kingdom, according to Cuvier's system, are described by their name. They have no bones, but consist of a soft substance; have no brain, but simply a nervous cord pervading the body; and have white blood. They are, upon the whole, an obscure department of the animal world, although some are used for

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237. What of the fourth order?
238. How is the third class distinguished?
239. Into what families are they divided?

food by the human race. They are divided into six *Classes*, as follows:—

The *Cephalopoda* are so named from having heads with feet. This class embraces several remarkable shell-fishes, as the Cuttle-fish and Nautilus. The former is remarkable for an ink-like excretion, with which, when in danger from other fishes, they can discolour the water around them, so as to escape, as it were, under a cloud. The Nautilus has a beautiful shell, which floats on the sea like a ship, and it derives its name from its putting up a small membrane, like a sail, by which it obtains motion from the wind. Fleets of Nautili are sometimes observed sailing over smooth seas within the tropics. The creature itself only occupies a small portion of the outer part of the shell. The rest is divided into numerous chambers, connected by a small opening with each other, and in these it can produce a vacuum, and so render itself light enough to ascend to the surface.

Nautilus.

The *Pteropoda* are so called from their having two feet, resembling fins, on the sides of the neck. Among them the chief is the Clio, which haunts the northern seas in immense numbers, and, though only about an inch long, constitutes the principal food of the whale.

The *Gasteropoda* are so called because they move upon their bellies, which are constructed so as to grasp or adhere to surfaces. The Common Snail is a specimen. To this class also belong the Limpet and the Whelk. It is divided into nine orders, which comprise numerous varieties.

The *Acephala* (headless mollusca) form the class of greatest importance, embracing most of the shell-fish which are appreciated for food. It is subdivided into two orders—*Acephala Testacea*, including the Oyster, Muscle,

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240. What is the second division and how marked?
241. What is remarked of the first class of these?
242. Name the remaining classes.

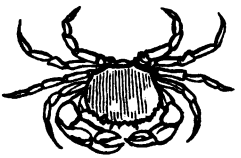
Clam, and many others; and *Acephala Nuda* (naked acephala), comprehending various small mollusca of very simple forms, which abound in the Mediterranean Sea.

The two last classes of Mollusca are the *Brachiopoda* (having two feet like arms), comprehending many creatures which inhabit bivalve shells; and the *Cirrhopoda* (clasper-footed), which are distinguished by having their bodies in small shelly departments. Of the last, the Barnacle is a specimen.

The Third Division of the Animal Kingdom is the ARTICULATA, or Jointed Animals, the chief characteristic of which is their having uniformly a hard or shelly external structure, divided into various joints or articulations. This is a more numerous and important department of the animal world than the Mollusca; it also contains a greater number of creatures which are interesting on account of their intelligence and peculiar habits. It is divided into four classes:—*Annulata* (ringed animals; *Crustacea* (crustaceous animals); *Arachnides* (animals having an affinity to the spider); and *Insecta* (insects).

The class *Annulata*, divided into three orders, includes all the creatures of the worm kind, excepting those which inhabit the bodies of other animals. They obtain their name in consequence of their bodies consisting in a series of rings, by collapsing and extending which they move forward.

The class *Crustacea* is divided into seven orders—*Decapoda* (ten-footed), including the Crab, Lobster, and prawn; *Stomapoda* (having hard-edged feet), including the Squill and Phyllosoma; *Amphipoda* (round-footed), including the Sand-hopper, a creature often seen jumping about in search of prey upon the beach; *Læmodipoda* (throat-footed); *Isopoda* (equal-footed), of which the Wood-louse is a familiar specimen. The



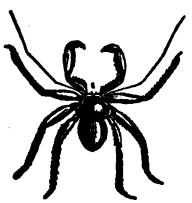
Crab.

243. What characterizes the third division?
244. Define the first and second classes.

above form a section of Crustacea, which bears the name of *Malacostraca*, on account of their being furnished with shelly teguments of a soft nature. Another section, called *Entomostraca* (insects with shells), comprises two orders; *Branchiopoda* (having feet like the gills of fishes); *Pæcilopoda* (various-footed), a tribe of minute creatures which infest the skins of fishes.

The class *Arachnides* is divided into two orders—*Pulmonariæ* (arachnides with lungs), including the House-spider, Tarantula, and Scorpion; and *Trachearíæ* (arachnides which breathe through tubes interspersed throughout the body), of which the Mite is a well-known, though diminutive specimen.

The Arachnides are almost entirely creatures of prey. The spider constructs, of threads which he draws from his body, a net, which he spreads across some neglected corner within our mansions, or between the branches of a bush, so as to catch flies, which he immediately rushes upon and destroys. In the processes necessary for this great end of his existence, he displays a degree of patient perseverance which may well be held up as an example to man. When his web chances to be destroyed, he loses no time in reconstructing it, though it is a work of great labour. The scorpion is a creature much larger than the spider, and has a poisonous sting which produces very painful effects upon those who are wounded by it. The mite inhabits putrescent cheese, and other substances in the same state. Small as it appears, it is a fully formed animal, with six legs, and nippers in the mouth for eating; it propagates by means of eggs, of which it lays vast quantities.



Spider.

The class *Insecta* embraces a very large proportion of the creatures composing the animal world. The name is descriptive of the form, which in general appears to be nearly cut into two or more portions. The class is di-

245. What of the third class?

vided into twelve orders—*Myriopoda* (many-footed), which are recognisable from their long slender bodies, and the great number of feet along their sides; *Thysanoura*, comprehending some creatures which live amidst old wood; *Parasita* (parasites), which infest the skins of other animals, including the Louse; *Suctoria* (sucking insects), of which the Flea is a specimen; [the preceding four orders bear the general name of *Aptera*, on account of their being without wings]; *Coleoptera* (sheath-winged), to which belong the Beetle, Death-watch, Cock-chafer, and many others; *Orthoptera* (straight-winged), of which the Grasshopper and Locust are specimens; *Hemiptera* (half-winged), including the Bug, Aphis, and Fire-fly; *Neuroptera* (nerve-winged), including the Dragon-fly, May-fly, Ephemeron, and the Termite, or white ant; *Hymenoptera* (membrane-winged), including the Ant, Bee, and some others; *Lepidopetra* (scaley-winged), including the numerous kinds of Butterflies and Moths; *Ripiptera* (fan-winged), which includes the Xenox and Stylops; *Diptera* (two-winged), of which the Gnat and House-fly are examples.

Insects are the most remarkable of the Articulata for their intelligence. In every part of the habitable globe, but particularly in warm climates, they are found in immense multitudes, constituting the common food of many larger animals. They are generally described as consisting of soft parts enclosed within a hard covering, never with fewer than six legs. Insects possess not only intestines, but organs for breathing, and a species of brain. They have no voice, but are not destitute of organs of hearing, seeing, smelling, and touching. In some the eye is very prominent, and consists of a multitude of facets, each of which is directed to a different point: of these, eight thousand have been counted in the eye of the common house-fly.

Insects feed on various kinds of animal and vegetable matter, and some are so voracious as to prove destructive

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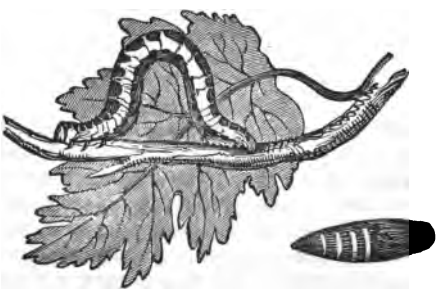
246. The varieties of the fourth class.
247. What of the intelligence of insects?

to gardens, forests, and fields of grain. They are generally of different sexes, the male being sometimes very different in external appearance and size from the female; in one instance (the white ant), the female attains a bulk between two and three hundred times larger than the male. The most of insects propagate by eggs, which some display great ingenuity in secreting in such places as are most likely to furnish food to the young. There are a few which contrive to dig into the bodies of other animals, even of man himself, so as to deposit their eggs in the flesh.

Several tribes of winged insects have a curious process of reproduction. The issue, for instance, of the egg of the butterfly is not a creature like herself, but a ringed worm, called a caterpillar, which lives for a time on vegetables, repeatedly casting its skin. In time it assumes a shorter



Butterfly in its first and second state.

and harder form, and falls into a state of torpor. In this state it remains for a certain term, to all appearance dead; but at length the exterior bursts, and the butterfly issues from it—at first somewhat soft, with short wings, but soon quite equal in vigour and length of wing to its parents. In the first state it is scientifically called the *larva*, in the second the *chrysalis*, and in the third the *perfect insect*.

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248. What wonderful peculiarities are cited?
249. What of the larva, and chrysalis?

These transformations have ever been regarded with a peculiar interest by man, as supposed to bear a resemblance to those changes in his bodily and spiritual nature which he himself trusts to undergo. Hence the ancient Greeks considered the butterfly as an emblem of the soul, and occasionally used the word *psyche*, which properly signifies the soul, to signify also a butterfly. It appears, however, that, in both of the earlier stages of the existence of the butterfly, the rudiments of the perfect insect can easily be traced.

Butterfly in its perfect condition.

Of butterflies, many thousand kinds have been reckoned. In tropical countries, particularly in Brazil, they are seen in great numbers, and of great size, one kind measuring nearly a foot between the extremities of the wings. They exceed all other insects in beauty. Each variety has wings variously coloured, and usually with great splendour. The colouring resides in close rows of inconceivably minute scales, which cover the membrane of the wing, as slates or tiles cover the woodwork in the roof of a house, and of which there are about a hundred thousand on every square inch of surface. Seventeen thousand lenses, each possessing the power of a distinct eye, have been counted in what appears one eye in this class of insects. These two circumstances, in conjunction, convey a singular impression of the bounty with which nature has lavished her labours upon creatures apparently destined for the humblest purposes; for we here find an insect gifted with per-

250. What of butterflies?

haps a million of scales, most curiously arranged and coloured, and with between thirty and forty thousand eyes, which is, after all, but a mouthful for the support of a bird to which all this beauty and ingenuity of structure is probably no recommendation.

Various winged insects, when in the *larva* state, wind off from their body, by an apparatus in their mouth, a clew of viscous thread, wherewith to cover themselves when in the chrysalis state. This covering is usually called a *cocoon;* the most remarkable example being that of the silk-worm, which is turned to good account by man, in forming one of the most elegant articles of clothing.

The honey-bee and the ant are insects of peculiar interest, on account of their habits. Both of these species, it is well known, live in a state of society much after the fashion of the human race. A hive of bees usually contains about twenty thousand, of which from one to two thousand are males, of an inactive character, and usually called *drones*. The rest of the community are females, in an imperfectly developed state, and form the industrious portion of the race. One of each hive, considerably larger than the rest, is the only true female. She is called the *queen*, on account of the authority she exercises over the hive, and lays eggs, from which are produced not only other queens, but also drones and *working-bees;* the larva of a working-bee being capable of becoming a queen, if treated to a richer kind of food. In reality, the queen is the only mother in a hive, and all the other female bees act only as nurses for the rearing of her numberless progeny.

Bee.

Bees, in common with other insects which derive nutriment from flowers, are provided with a proboscis, or long flexible snout, with which they can suck up the sweet matter which resides in the deep tube-shaped *corollæ*, or flower-cups. The matter thus sucked up is deposited in a little bag in the abdomen of the insect, and brought home.

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251. Define a cocoon, and its uses.
252. What is related of bees?

In one class of working-bees, it assumes a waxen consistency; in another it becomes honey. With the wax are built ranges of little cells, depending in cakes from the roof of the hive, for the reception and safe-keeping of the honey. Working-bees are also furnished with bristly feet and bodies, for the purpose of brushing off the pollen of flowers and collecting it in little pellets, which they bring home in a kind of natural basket upon their hind legs, as food for their young in the larvous state. The honey is designed by them to serve for their own food, and it is amassed as a provision against the winter, during which they must be informed by a divine intelligence that there are no flowers. In order that their stores may go as far as possible, they always kill the males after there is no longer any use for them—a feat which they accomplish by means of their sting, a poisoned weapon situated at the hinder extremity of their bodies.

Ants not only show equal or superior industry to the bees, and live like them, in societies, but display a power of constructing habitations which far transcends the ingenuity of the bees in the formation of their cells. It is chiefly to tropical countries that we are to look for the most remarkable examples of the industry, ingenuity, and great collective power of this insect. The ant-hills of Africa and South America have been long noted for the ingenuity of their structure, some compartments being set aside for food-stores, others for nurseries for the young, and others for defence and shelter. The community is also divided into several orders, such as workers, defenders, and royal inmates, each performing their several duties with astonishing regularity and order, whence the ant has become among men a proverbial example of diligence and industry.

The Fourth Division of the Animal Kingdom is the Radiata, so called on account of their figures being generally branched, or radiated, though, as this department of nature has not been as yet well investigated, it is probable that some more comprehensive designation will in time be given to it. The term *Radiata* is, in fact, merely one of

253. What is remarkable in ants?

convenience, being made to apply to creatures which have no such peculiarity of form, but are only put into this division as ranking with the rest in point of obscurity of character.

The division comprehends five *Classes*, which are again subdivided into orders; but, in all except one case, an enumeration of the former may suffice. The first class are called *Echinodermata*, from their prickly skins. Of these creatures, the Star-fish and Sea-urchin are familiar examples, being often found upon our shores after the sea has receded. The second class are the *Entozoa*, or Intestinal Worms. These, as their name imports, inhabit the intestines of larger animals, and even the brain, liver, and other parts of the body, where they propagate their kind, in some instances by means of eggs. By what means the germs of such creatures find access to the interior of the bodies of other animals, is not known. One, called from its shape the Tape-worm, sometimes reaches the length of a hundred feet. The third class are the *Acephla*, of which the Medusa or Sea-jelly is an example. This creature resembles the top of a toadstool, of a jelly-like consistence, with filaments hanging downwards, and it moves through the sea by means of a peculiar power of self-contraction.

Star-fish.

The fourth class, *Polypi*, are divided into several orders, all of which inhabit the water, salt or fresh. The first order, *Carnosi* (fleshly), resemble plants or flowers in their figures, and hence a particular family are called Sea-anemones. The stalk contains a stomach, and around a mouth at top are numerous arms or tentacula (feelers), which float about in search of prey. The creature is altogether of so simple a character, that, if turned inside out like a stocking, the

Sea-anemone.

254. What of the Radiata, and their varieties?
255. What of the Polypi?

new interior serves as a stomach quite as well as the former one, and the whole economy of the animal, such as it is, proceeds as usual. Their young spring out from their sides, and, when ready for an independent existence, part off with a jerk; but any small portion of the creature cut off from the rest, will in a short time grow into a complete polypus. The second order, *Gelatinosi* (gelatinous polypi), are not greatly different from the Carnosi.

The third order, *Coralliferi* (coral-bearing), constitutes a numerous suite of species, which were long considered as marine plants, but finally were ascertained to be compound animals, of very wonderful habits and character. From the hard bottom of the sea arises something in the form of mushroom, fern, shrub, or tree, of a hard consistence, and full of little holes. It is, in reality, an animal, or rather cluster of animals, each occupying its little cell in connection with the rest, and working towards a common object. In the Southern and Pacific Oceans, these corals and madrepores, as they are called, are raising vast beds of calcareous or limey matter from the bottom to the surface of the sea, some of which form *reefs*, of great danger to seamen, while others have been covered with soil and vegetation, so as to become habitable islands. One kind of the Coralliferi, of which there are upwards of a hundred varieties, grow from the bottom of the Red and Mediterranean Seas, in the shape of large fungous plants, (plants like mushrooms or apple-tree fog,) consisting of a soft porous substance, pervaded by tubes in all directions, and capable of being irritated by touch. When torn up and cleared of a certain external matter, in which their life is said chiefly to exist, they become the well-known useful substance called *sponge*.

Coral.

The fifth class of Radiata are the *Infusoria*, or Animalcules usually found in stagnant water and other putrid fluids. Here we have an animal world, of which our senses fail to inform us, and which can only be surveyed

256. Describe the third order.

by means of the microscope. The smallest animalcules as yet observed are called *Monads*, being merely little points of matter, which, though apparently destitute of organs of motion, are never for a moment at rest. Animalcules appear to reproduce in a manner of their own. If the water containing them be kept stagnant, the simpler in form produce others of more complicated kinds, and these again others more complicated still. Next to the monads in simplicity of figure are the *Rotiferæ*, so called from the wheel-like appearance of certain parts of their bodies. The Rotiferæ occur in the most varied and grotesque forms; some resembling eels, snakes, and horns; others twisted and bent like screws and branches of trees; while many assume the forms of tulips, egg-cups, and other shapes equally curious. Some of them are supposed to propagate by eggs; but the most do so by dividing their own bodies into parts, each of which becomes a new animal of a different shape from its parent. A great number are rapacious, and it has been observed that the occupants of two drops of water which have been brought from different places, were at peace among themselves while the drops were kept separate; but no sooner had the two drops been thrown into one, than a scene of strife and destruction was presented. How strange to reflect, that the same Being who peopled infinite space with ponderous globes, has breathed a peculiar intelligence into specks of matter, of which thousands would require to be thrown together before they could become perceptible to the most searching human vision!

Rotiferæ.

The science which treats of animals, their varieties, habits, and modes of life, is called Zoology. The subject is divided into several departments, under particular names —as *Mazology*, the science of suckling animals; *Ornithology*, the science of birds; *Ichthyology*, the science

257. What of the fifth class and their variety?
258. Define all the technicals.

of fishes; *Helminthology*, the science of worms (including all kinds of snakes); *Entomology*, the science of insects; *Conchology*, the science of shells; and *Zoophytology*, the science relating to all those lower orders of animals which take the form of plants. The consideration of the structure and internal economy of animals forms a distinct branch of science, named *Animal Physiology*.

ANIMAL—from the Latin *animal*, a living creature, and that again from the Greek *anemos*, air or breath; hence originally applied to all creatures endowed with the breath of life.

ANIMALCULE—from the Latin *animalculum*, a little animal; all minute animals which require the aid of the microscope to render their parts distinctly visible, are termed animalcules.

MICROSCOPE—from the Greek *mikros*, small, and *skopeo*, I look; an instrument for looking at minute objects so as to render them distinctly visible.

AMPHIBIOUS—from the Greek *amphi*, both, and *bios*, life; applied to animals that live sometimes on land and sometimes in water.

ZOOLOGY—from the Greek *zoon*, a living creature, and *logos*, a discourse; the science which treats of, or discourses on, living creatures.

MAN—HIS GENERAL CHARACTER AND HISTORY.

Man has been described in the preceding section as forming a special order in the range of animated beings. He is distinguished from all others by a great superiority in intelligence, and by his possessing a moral nature. He is not, however, in every country the same creature. Europe, the western part of Asia, and the north of Africa, have been possessed since the dawn of authentic history by a white-skinned race, the highest in intelligence, and the most elegant in form, named the Caucasian variety, as being supposed to have originated among the mountains of Caucasus, between the Black and Caspian Seas. The remainder of Asia has been at the same time occupied by an olive-yellow-coloured race, of less intelligence and vigour of character, named the Tartar or Mongolian variety, from Mongolia, a country to the north of China. A third race, of black skin, coarse features, and small intelligence, have inhabited the greater part of Africa: they are denominated the Negro or Ethiopian variety. [The Malay race are

259. Name the varieties of the human species.

found in the Pacific islands and in Malacca, constituting a fourth variety, and their colour is a dark brown. They are here enumerated in their numerical order, as estimated, viz.:

Caucasians, 47 per cent. of the population of the earth.
Mongolians, 41 per cent.
Ethiopians, 8 per cent.
Malays, 3 per cent.
Americans, 1 per cent.]

In America, when it was discovered three hundred years ago, a fifth race, of a red or copper-colour, and of no great intelligence, was found in a generally barbarous condition. [In speaking of the comparative intelligence of the different races of men, very much of the inferiority alleged, is to be ascribed to their condition and circumstances in the absence of civilization, and more to the character of their religions, which have a tendency to degrade the intellect and prevent its development.]

The white-skinned variety are remarkable for their cultivation of letters and science, and as the only race amongst which any considerable progress is made in intelligence from age to age.

Egypt, Arabia, Persia, Mesopotamia, Syria, and Greece, were the countries in which this race made their first advances in literature, science, art, and government. The Israelites, or Jews, descended from Abraham, an Arabian shepherd who lived nineteen hundred years before Christ, are remarkable among its various tribes for the historical circumstances narrated in the Bible. The inhabitants of Greece are also conspicuous for their high intellectual character, which they exemplified in productions of art and literature, scarcely ever since excelled. The Romans were for many centuries pre-eminent above all other nations for their great warlike power and general vigour of character. From about ten centuries before the Christian era, to six centuries after it, the nations on the northern shores of the Mediterranean, particularly the Greeks

260. For what are the Caucasian variety remarkable?
261. What fragments of history are cited?

and the Romans, are found to have advanced out of, and again in a great measure sunk back into, barbarism. All that period of the world's history which preceded the sixth century of the Christian era, is regarded as the *times of antiquity*, and the people of those days are generally called the *ancients*. After an interval of comparative barbarity, termed the *middle ages*, which extended to the fourteenth century, civilization gradually revived; the literature of the ancients was resorted to for its refining ideas and its philosophy; the Christian religion, which had originated in Judea under the circumstances narrated in the New Testament, began to exercise its proper humanizing effect; and the nations of Europe, especially those of Italy, Spain, France, Germany, and Britain, advanced to as high a state of mental culture, or even higher, than ever had been attained by the ancients. From these countries, the white race has more recently spread, with its religion, literature, science, arts, and ideas of government, to the eastern shores of America, of which continent it promises in time to become entirely possessed.

While the white race has been making this progress in one direction, it has relapsed, in the countries where it first flourished, into a state little superior to that of the coloured nations. In Egypt, Arabia, Persia, Mesopotamia, and Syria, the literature, science, and institutions, of which they gave the first examples, are now nearly unknown, while the ruins of their works of art alone remain to attest their former greatness.

Of the sciences, or branches of knowledge, relating expressly to man, that which traces the personal peculiarities of the various tribes, is termed the *Physical History of Man;* that which describes the countries occupied by the various nations, with regard to the numbers, character, and general circumstances of those nations, is termed *Political Geography;* that which traces the different languages spoken by the different nations, is termed *Philology;* that which traces the transactions of nations throughout considerable spaces of time, is termed *History;*

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262. What relapses have taken place?

that which presents memoirs of the lives of remarkable individuals, is *Biography;* while that which expounds the laws that govern the production, distribution, and consumption of the results of national industry, is *Political Economy.*

All of these sciences and branches of knowledge are of great importance, and ought to be in some degree familiar to the mind of every individual. But there are other two, of still more direct and immediate importance, seeing that they are indispensable for the preservation of health, and the regulation of conduct. These relate to the bodily nature of man (*Human Physiology*), and to his mental nature (*Moral Philosophy*).

PHILOLOGY—from the Greek *phileo*, I love, and *logos*, a discourse or learned treatise; the love of discourse, or an attachment to literature; hence specially applied to the study of written languages.

BIOGRAPHY—from the Greek *bios*, life, and *grapho*, I write; the science of life-writing.

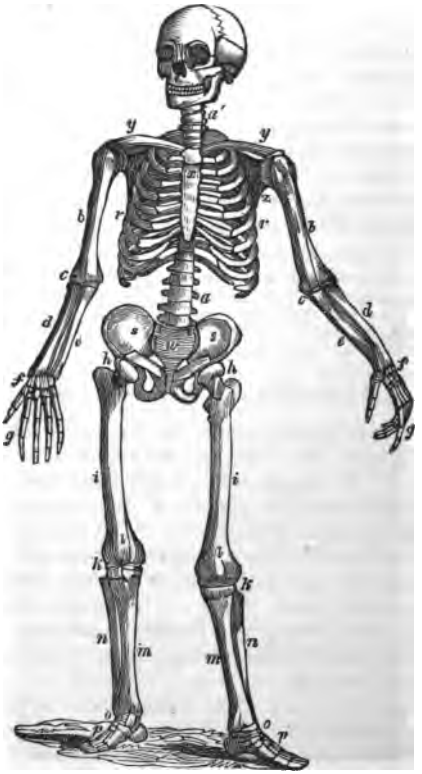
MAN—HIS BODILY NATURE.

The external appearance of the human being is necessarily familiar to all. The general stature is between five and six feet; the figure, without great strength or agility, exhibits, in its upright posture, a dignity appropriate to the master creature of the world. The infancy of man is longer than that of other animals: he does not attain his full growth till he is upwards of twenty years of age. For other thirty years, if not cut off by disease, he is in the prime of his strength. Twenty years more constitute elderliness; and if he survives seventy years in all, he is said to reach old age.

(*Osseous System.*) The human body is constructed upon a framework of bones, termed the *skeleton*, of which the engraving on next page is a representation. [The skull or *cranium* of an adult, contains thirty-one distinct bones, exclusive of thirty-two teeth. There are eight bones belonging to the skull proper, fourteen to the face, eight to

263. How is the science of man divided?
264. What is said of man's bodily nature?

the internal ears, and one to the tongue. Numbering the teeth as bones, the head may be said to contain sixty-three. Besides the skull,] the principal part of the



structure is the *spine* or *back-bone* (*a a*), a column consisting of twenty-four separate bones, upon the top of which is the *skull*. The *ribs* (*r r*) curve forwards from the back-bone, and most of them meet in front, in a bone termed the *sternum*, or breast-bone (*x*). The *collar-*

bones (*y y*) extend from the *neck* to the *shoulder-blades* (*z z*), where commence the *arms*, consisting of the *humerus* (*b*), the *radius* (*d*), and the *ulna* (*e*), the two latter being joined to the humerus at the joint termed the *elbow* (*c*). At the extremity of the arm are found the bones of the wrist and hand, consisting of the *carpal* and *metacarpal* bones (*f f*), and the *phalanges* or finger-bones (*g*). The back-bone rests upon the *sacrum* (*w*), which is fixed between the two bones of the *pelvis* (*s s*), forming the basis of the trunk. From the bones of the pelvis proceed the thigh-bones (*h i*), constituting the upper portion of the limbs. At the knee, where there is a small detached bone called the *patella* or *knee-pan* (*l*), commences the *tibia* (*m*), usually called the leg-bone. This is supported by a smaller parallel bone, termed the *fibula* (*n*), which, though not connected with the knee-joint, unites with the tibia in forming the ankle or *tarsus* (*o*). At the ankle-joint the leg is connected with the foot (*p*), which consists of a number of small bones corresponding in number and form to those of the hand, and designated as tarsal, metatarsal, and the phalanges of the toes, which together form the basis of the whole body. The bones in the human skeleton are two hundred and forty-eight in number, each being fashioned in a way suitable to the purpose which it serves. [These 248 bones are thus classified, viz.:

In the *head* 63, viz.:	cranium	8
	face	14
	ears	8
	tongue	1
In the *trunk* 53, viz.:	spine	26
	chest	25
	pelvis	2
In the *arms* and *hands*		64
In the *legs* and *feet*		60

besides 8 sesamoid bones, found about the joints of the thumb and great toe.] They are of a hard white substance, composed of lime, with a small proportion of animal matter.

265. Describe the bony structure of man.
266. Explain every part of the skeleton.

Upon this framework, which, not being intended to be seen, possesses no qualities pleasing to the eye, the whole remaining substance of the body is arranged and supported.

(*Muscular System.*) A great portion of the soft substance of the body consists of what is termed fleshy or muscular fibre. The mass of muscular fibre is divided into upwards of four hundred bundles, singly denominated muscles, varied in size and strength according to the purposes which they are designed to serve. Muscles may be described as bundles of soft red fibres, of a cylindrical form, and running in a parallel direction. In the limbs, where the chief muscles of motion are placed, the two extremities are attached to parts which have a joint between them: when the mind desires to exert one of the limbs, it sends a command to that purpose through communicating nerves, and the muscle expands, contracts, and moves in the manner desired. All the muscles along the exterior of the body are thus under the control of the mind; but, in the interior, there are muscles necessary for the circulation of the blood, and the digestion of food, which are necessarily exempt from the will, because their functions are required at all times, in sleep as well as in our waking hours. These are termed Involuntary Muscles.

(*Nervous System.*) The whole surface of the body is pervaded by fine cords, called nerves, which communicate with the brain and spinal marrow, and serve at once to convey the information of the senses to the mind, and to transmit the will of the mind to the muscles. The brain itself, the spinal marrow, and the nerves, are collectively called the Nervous System, because they are apparently united in one order of function. The nerves are of parallel minute white fibres, each enclosed in a cellular sheath, and consisting of two parts, one of which serves for sensation, and the other for motion.

The brain is a white pulpy mass, placed in the cavity

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267. Describe the muscular system.
268. What of the nervous system?

of the skull. It is thready or fibrous in texture, and amply supplied with blood-vessels. Being, as ascertained by observation, the organ of the mind, it is protected with all the care due to so important a functionary. The skull which covers it is an arch of the strongest construction, composed of several parts, united by tooth-like or jagged edges, which fit into each other, so that, if an injury does take place, it is apt to stop short at one of the joinings. The brain has an interior division, which separates the principal mass from a smaller portion at the back: this smaller portion is termed the cerebellum (that is, the little brain). It is also continued in a long cord down along an opening in the column of the spine; this is usually called the spinal cord, or marrow. The least injury to the spinal cord—even so much as the prick of a pin—causes death.

The nerves which communicate with the senses, the lungs, and the stomach, originate in the brain; those required for the motion of the extremities, come from the spinal cord. Another system of nerves, called the Sympathetic, which cannot be observed to have any direct connection with either the brain or the spinal cord, are seated in the breast, and are supposed to give the power of motion to the involuntary muscles.

Perception of the external world is communicated to the organ of thought by the senses, which are five in number:—

Sight, or perception of the forms and colours of objects, is effected by the eye, the external appearance of which is well known. The pellucid ball of which the eye consists, is obscured all over the front, except in one small part (the *pupil*), through which the appearances of things pass into the interior. At the back of the ball, opposite to this aperture, is a net-like membrane (the *retina*), upon which these appearances are represented, as in a looking-glass, their size being reduced by an intermediate lens. The retina is an expanded nerve, which, immediately behind, collects into the usual form, and communicates to the brain.

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269. Describe the brain and nerves.

Hearing, or the perception of sound, is in like manner effected by a nerve spread out upon a membrane called the *tympanum*, which stretches, like the cover of a drum, across the hole within the ear. Sound is a peculiar agitation of the air, and this agitation acts upon the tympanum in the same manner as it is often found, when cannon are fired, to act upon the windows of a house; that is to say, it shakes the tympanum, the nerve of which conveys a report of every fine peculiarity of the impression made upon it to the brain. Connected also with the tympanum, there is a number of small cells, which are supposed to reverberate the sound, and heighten the impression carried by the nerve to the great centre of perception.

Taste chiefly resides in nerves pervading the surface of the tongue, the skin of that membrane being pierced with numerous pores, to admit substances to a contact with them.

Smell, in like manner, resides in nerves beneath the skin of the interior of the nostrils.

Touch, or the perception of the contact of objects, resides in nerves which pervade the whole surface of the body, but are nowhere so numerous or so fine as in the points of the fingers, which have evidently been designed as the chief organs of the functions of this sense.

(*Sanguineous System.*) The whole body, not exclusive of the bones, is pervaded by a red fluid, termed the *blood*, which circulates by means of vessels or tubes, which at their extremities are inconceivably small. The organs necessary for propelling this fluid upon its course through the body, and the organs required for communicating to it the food and air necessary for sustaining its vital character, are placed within the cavity of the ribs, in the upper part of the body. The chest, as this cavity is termed, is divided from the lower region of the body by a horizontal muscle, the diaphragm (D D), which rises and sinks according as we are drawing or expelling our breath. The right side of the chest is divided from the left by a thin

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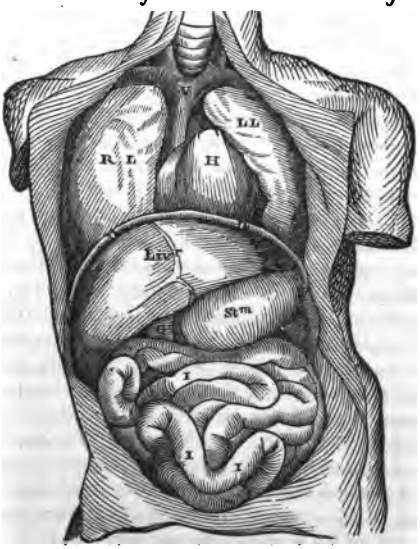
270. What of the senses, sight and hearing?
271. What of taste, smell, and touch?

membrane, which separates into two layers at the back part, forming a canal, through which the gullet passes to the stomach. In the left cavity are situated the heart (H), and left lung (L L); the other side is entirely filled by the right lung (R L). The *heart* is a strong muscular bag, the sides of which are from a quarter to half an inch thick, and are composed of circular and longitudinal fleshy fibres. The use of this membrane is to act as a force-pump for sending the blood through the various channels of the body: it may be likened to the water-works which send water through a town in pipes. It has two divisions, between which a strong partition exists, and each of these is subdivided into two cavities, called *auricles* and *ventricles*. The right side of the heart has its auricle and ventricle, and the left has the same. By the contraction of the *left* ventricle,



Interior of the Body.

272. Describe the sanguineous system.
273. What of the heart?

the blood is sent into vessels called *arteries*, and carried by them to every part of the frame. The blood, thus distributed, is re-collected by another system of vessels, termed *veins*, which bring it back to the *right* auricle of the heart, from which it passes into the right ventricle. The blood has now passed through every portion of the body, and this is called the *first* or *primary circulation*. From the right ventricle the blood is transmitted by arteries to the lungs, circulates through them, and is again collected by veins, which carry it to the left auricle of the heart. From this it passes into the left ventricle, the point from which it started, and is distributed anew over the frame. This passage through the lungs is called the *secondary circulation*. Every emission of the blood from the heart is felt even at the extremities, and is termed a *pulsation*. The entire quantity of blood in a full-grown person is estimated to be from twenty-four to thirty pounds.

The *lungs* are the organs of respiration or breathing. They are of a light, elastic, spongy texture, being little else, indeed, than an interwoven series of air-tubes, air-cells, and blood-vessels. The air, inhaled by the mouth, enters a large tube called the *windpipe*, which divides at the upper part of the chest into two branches (the bronchial tubes), one of which goes to each lung, and separates into innumerable smaller branches through the whole extent of the organs. The terminations of these air-tubes are so small, as to be indistinguishable either by the eye or glass, and they mix intimately with the equally minute ends of the blood-vessels. This admixture is for the fulfilment of the purpose which the lungs serve in the system. One of the nutritious and vital principles which the blood has to impart to the body, is oxygen. After it has done this during the primary circulation, it is brought by the secondary circulation to the lungs, and there, being brought into close contact with the air-tubes, it extracts from them the oxygen of the atmospheric air, and returns immediately to the heart to be circulated, and give out its absorbed oxygen anew.

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274. What of the lungs, and their functions?

(*Digestive System.*) Beneath the diaphragm are situated the *alimentary organs*, consisting chiefly of the *stomach* and *intestines*. When food has descended through the gullet into the stomach (marked *St*^{m} in the foregoing engraving), it is there subjected to the influence of a fluid termed the *gastric juice*, which, in ordinary circumstances, has the power of dissolving the most solid meat. The process called *digestion* is the reduction of the aliment, by the solvent properties of the gastric juice, to a whitish half-fluid substance called *chyme*. In this state it passes out of the stomach by the lower opening named the *pylorus*, which possesses a sensitive power, enabling it to reject the matter not operated upon by the gastric juice. In the upper part of the intestines, called the *duodenum*, the chyme receives a fluid from the liver, termed *bile*, and another from the pancreas (or sweetbread), called the *pancreatic juice*, which form it into *chyle*. In this state it is absorbed by innumerable minute vessels termed *lacteals*, and passes upwards through the chest by a long duct (the *thoracic duct*), till it is ultimately poured into one of the veins of the neck, and afterwards thoroughly mixed with the blood in the lungs, to nourish the body. All the remainder of the food not acted upon by the gastric juice is expelled from the body by the *intestines* (I I I). These, in form, do not resemble the stomach, which is a large bag, but are canals, varying from one to two inches in diameter. They are divided by anatomists into six portions, termed the *duodenum*, *jejunum*, *ilium*, *cæcum*, *colon*, and *rectum*, the last being the terminating portion.

(*Secretory and Excretory Systems.*) After the blood has received, by the process described, the essence of the food, besides the general purpose of supplying vital nourishment to the frame, it performs several obscurer but not less important functions, termed *secretions* and *excretions*. The principal secreting organs are the *liver* (marked Liv^{r} in the foregoing engraving), the *pancreas* and the

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275. Explain the organs and process of digestion.
276. Define all the technicals.

salivary and *lachrymal glands*. The liver is a large organ, of a dark colour and soft consistence, situated in the upper and right side of the intestinal cavity. It is remarkable for being pervaded not only by arteries, but by the large vein which brings the blood from the lower extremities to the heart. It is not absolutely certain which of these circulations, the venous or the arterial, secretes the bile. [The bile is the natural purgative of the body, and when in healthful quantity and quality, the system is kept in a regular state, and costiveness is not present.] The pancreas is a small body, resembling a dog's tongue in shape, and lying close upon the stomach. Its only purpose is to secrete the fluid which assists in converting the food into chyle. The salivary glands are placed in and around the mouth, and pour out the saliva to assist in the mastication of the food. The lachrymal or tear glands are situated in the inner corner of the eye-socket: without being constantly wetted by that fluid, the eye would be incapable of motion, and liable to constant injury from the sun and air. Many other small secreting bodies exist, for the purpose of moistening the surfaces on which they are found; as, for example, the bronchial glands in the air-tubes, the mucous glands in the bowels, and the glands below the skin for secreting the fat, which serves as a protection to the frame. In all these secreting organs, we see that there is a fluid formed, but by what process of separation from the rest of the blood, we cannot comprehend.

The principal excretory organs are the *kidneys*, the *skin*, and the *bowels*. The bowels simply form a canal for carrying off the refuse of the food; but the kidneys and skin secrete and remove what appears to be a refuse of the blood. The office performed by the skin is to pour off what is termed the insensible perspiration, or *sweat*. [This is obviously but a meagre outline of Human Anatomy and Physiology, but will serve as intended, only as introductory to these important sciences, now justly regarded as indispensable to any system of education.

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277. Explain secretion and excretion.
278. Which are excretory and secretory organs?

(*Preservation of Health.*) Health, the greatest of all earthly blessings, depends on the body being kept in such a condition as to allow the whole of the organs to exercise their functions in the way intended by nature. Disease, on the contrary, arises either from an injury to the structure of the organs, or from a derangement in their functions. Death, occurring before old age, if not occasioned by original deficiency, is invariably the result of accidental injury or derangement.

It is not, of course, within the power of individuals to remedy original weakness or deficiency; neither can they make sure of avoiding the numerous diseases which extend by contagion and infection. It is possible, however, by knowledge and care, to do much for the preservation of health and prolongation of life in ordinary circumstances.

In the first place, to prevent injuries to the structure of our bodies, a knowledge of the laws of nature is of great service. We ought not only to know, what is known to very young children, that fire burns, that hot water scalds, that a fall from a considerable height will severely hurt us, and that edge tools will cut the fibre and give us much pain, but we ought to become extensively and systematically acquainted with the laws under which the material world is conducted, so that, while they are in general acting, as designed by a kind Providence, for our advantage, we may so act in regard to them, as to prevent their operating occasionally, as they are apt to do, to our injury or destruction.

In the second place, to prevent the dangers arising from the derangement of the functions of our bodies, a knowledge of the laws of these functions is necessary. Four things, above all others, are required for keeping the organic structure of the body in a healthy performance of its functions. These are *air, food, exercise,* and *cleanliness;* and all must be administered under proper regulations.

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279. Define health and disease.
280. What is said of the laws of nature?

Air is only in a proper state for supporting the organic functions when it has a fifth of oxygen in its composition —that is, in its usual state, as found in the atmosphere. In a room which does not communicate freely with the open air, we soon reduce the quantity of oxygen; *every breath we draw in such circumstances is detrimental to health.* Hence, all sitting and sleeping apartments should be large and high in the ceiling, or else should have a constant communication with the open air. Churches, schools, factories, and all places where multitudes assemble, should be well ventilated. The air, however, is nowhere so wholesome as out of doors; and there, accordingly, every human being should spend a considerable portion of every day.

Wholesome *food* is the second great requisite for health. Of the numerous articles of food, some are not easily digested, as pastry, dried and pickled animal food, oily dishes, and fruits, especially those which consist of the kernels of nuts, as filberts, almonds, and castanas. These, being likely to derange the stomach, and occasion pain, ought to be avoided, or only indulged in very sparingly. Of the beverages commonly in use, all those which contain alcohol in any proportion, as wine, brandy, gin, whiskey, cordials, porter, beer, cider, &c., are hurtful to the digestive powers if taken in health, and especially to the young, who will find their comfort and happiness promoted by total abstinence from all such drinks as may intoxicate. When a judicious selection of articles of meat and drink has been made, it is still to be remembered that a certain quantity is all that nature demands. If, under the influence of a false appetite, we eat or drink more than is required for sustenance, we overload and embarrass the stomach, and prepare for ourselves many serious evils.

While we thus take care to supply the blood with what it requires for the support of the system, we must also adopt the necessary measures for enabling the same fluid to perform the functions assigned to it.

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281. What four important things are named?
282. What illustrations are cited concerning air?
283. What is said of food and beverages?

For this purpose, moderate *exercise* is necessary. The direct object, let us observe, of *supply*, is to allow of *waste*. As fast as the body is taking in new substance, it is giving off something equivalent; and thus a perpetual freshening flow is kept up. Now, in a state of inactivity, this flow is too languid. A certain animation of mind, and a certain exertion of the muscular system, are necessary for keeping it up; for the muscles, when exerted under the influence of a willing and sprightly mind, take in fresh substance from the blood, which thus becomes appetized for new nutriment. The general design of this part of the animal economy is obvious. We were designed to *labour*—to make our bread by the sweat of our brow. We have therefore been provided with organs calculated to perform labour. When these organs are used in the way ordained by nature, namely, in a moderate exercise, her intention is fulfilled, and health is the consequence. When, from indolence or bad habits, we do not exercise our bodily frames, infirmity and ill health necessarily ensue. It is chiefly in the upper ranks of society, and more particularly among the female sex, that the consequences of neglect of exercise are observable; but much injury is experienced from the same cause, by individuals who are kept, during too large a portion of the day, at sedentary employments. When, in addition to imperfect exercise, there is a want of pure air, the evil consequences to health are proportionally increased. On the other hand, the mind and body ought not to be exercised above their strength, for by such means either may be so injured that death will ensue.

The fourth requisite for health is *cleanliness*. Bathing, entire or partial, and frequent and regular changes of apparel, are necessary for the preservation of the skin in a fit state to perform its excretory function. Not knowing this, or from bad habit, many individuals do not wash themselves sufficiently, and hence not only render their persons less healthy and more liable to disease, but become unseemly and disagreeable to others. The cleanness of our clothes,

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284. How is exercise shown to be important?
285. What instructions are given respecting cleanliness?

however humble, is equally necessary; and our apartments should be kept dry, and regularly swept, and well aired. As with our persons and houses, so with our streets and towns we dwell in: they should be daily cleaned, and no putrid matter or stagnant water be allowed to collect in their vicinity. It is of great importance to form habits of cleanliness in early life. When thus formed, they soon cease to appear troublesome, and are scarcely ever after neglected.

Osseous—from the Latin *os*, *ossis*, a bone; bony, or partaking of the nature of bone.

Sanguineous—from the Latin *sanguis*, blood; belonging to, or partaking of, the nature of blood.

Nervous—from the Latin *nerva*, or Greek *neuron*, a cord or sinew; hence applied to the nerves, from their cord-like appearance.

Digestive—from the Latin *dis*, asunder, and *gestus*, carried or conducted; hence the term is applied to those functions of the stomach by which the food is digested, or taken asunder, so that the nutritive portion may be appropriated to the support of the body.

Diaphragm—from the Greek *dia*, through, and *phragma*, an enclosure; applied to the muscular partition which divides the interior of the body into two separate enclosures.

Secretory and Excretory—from the Latin *se*, aside, *ex*, out of, and *cretus*, sifted or divided; hence secretory is applied to organs which separate or set aside certain fluids of the body for particular purposes, such as the gastric juice, which is a secretion; and excretory to those organs which throw certain fluids out of the system altogether, such as perspiration, which is an excretion.

MAN—HIS MENTAL NATURE.

The brain has been already mentioned as the recognised seat of the mind and the centre of sensation. By this it is not meant that the brain is itself the mind, but merely a material organ, charged by Almighty power with the functions of the mind, which, in itself, we are taught to regard as a spiritual and distinct essence, destined to survive the dissolution of all matter whatever. [Hence the brain is the instrument or organ by which the mind performs its various functions, as the eye is the instrument by which the mind exercises the faculty of vision, though the mental perception takes place in the brain, in this as in all other examples of sensation.]

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286. What is said of the mind and brain of man?

When we consult consciousness, we feel as if the mind were a scenic chamber like the camera obscura, into which the senses are constantly transmitting pictures of what is presented to them in the external world, and through which, even when the external senses are at rest, there is a perpetual flow of the recollections of former images, which we will sometimes vainly endeavour to interrupt or banish. We also become conscious that this something within us has a power of representing to itself things which may or may not be, of throwing them into new and more striking arrangements, and investing them with attributes of more than earthly beauty and sublimity. The mind likewise, is felt to be that in which we feel affected regarding the various things and actions presented to our notice, and which governs our conduct in daily life.

While thus, in one respect, a single and indivisible thing, it may be divided into various instincts or faculties, each of which will be recognised by us as in some measure independent of the rest, and as possessed by various individuals in various degrees of power or activity, so as to give rise to that variety of talents and dispositions which is observed amongst mankind. These faculties may be primarily divided into two great classes—the faculties of the intellect, and the affective or sentimental faculties; the one class having chiefly to do with knowledge, the other with conduct.

The intellect, again, appears to comprehend two orders of faculties. [Without adopting the distinctive dogmas of any one of the phrenological schools, the classifications they have suggested of the mental faculties and moral sentiments have the merit of convenience for our present purpose, with suitable modification.]

The order of intellectual faculties earliest developed in our minds, comprehends those which are limited expressly to the attainment of knowledge, and are therefore usually called the *Knowing Faculties*. They are—the faculty of language, the faculty for observing external objects, the faculties for observing the qualities of external objects,

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287. What two orders of faculties are named?

as their *form*, *size*, *weight*, and *colour*; and finally, the faculties for observing the relations of external objects, as their *place*, *number*, *order*, *action*, *time*, and *sound*, the relations of the last being what constitute music.

The other class of intellectual powers, usually not fully developed at so early a period of life, are denominated the *Reflecting Faculties*, being two in number. One may be called the faculty of *Comparison*, because its office is to call the ideas of various objects and actions together, and show their difference and resemblances. This is the power chiefly exercised by the poet, the wit, and the orator; in whose writings and sayings, much of our pleasure depends on the ingenuity with which ideas, usually considered as distinct, are shown to have relations of some sort to each other. When these ideas are alike elevated, poetry is the consequence—when one is elevated and the other mean, the result is comical and ludicrous.

The second of the reflecting faculties is *Reason*—in other words, the faculty for observing *cause and effect*, or necessary consequence. It is the noblest of all the intellectual powers, and that which chiefly distinguishes man from the lower animals. Gifted with this faculty, man traces, in certain regular causes, certain necessary results, and thus acquires a great influence over his fate. For instance, by observing that a particular kind of conduct is attended with painful consequences, he is enabled to avoid that kind of conduct, and consequently to escape its effects. In its highest forms, this faculty causes men to become distinguished as philosophical inquirers. It also enables men to act readily and wisely in critical circumstances.

The Affective Faculties are those functions of the mind by which we manifest and experience certain well-known feelings. Some of these feelings may be called Moral, because they incite us to good actions. Others may be termed Selfish, because they regard immediate gratification for ourselves, or things connected with our own interests.

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288. Define and illustrate each.
289. What of reason?
290. Name the moral sentiments, and define.

First among the moral sentiments stands *Veneration*, which inspires respect for those persons and things which are more worthy than ourselves—especially the DEITY, who is the author of nature, and has given us all the blessings we enjoy. Next may be reckoned *Benevolence*, which prompts us to do all in our power to promote the comfort of our fellow-creatures, and makes us willing to forgive those who offend us. *Justice* is entitled to the next rank: by this sentiment, otherwise called the *Conscience*, we are constrained to render to our fellow-creatures what is their due, or to repent having done otherwise; it also prevents us from violating any rights of theirs, or, if we do violate such rights, it fills us afterwards with bitter self-accusations, and incites us to do what we can to repair the wrong. The exercise of these three sentiments is enjoined in the Scripture text, which tells us that practical Christianity consists in doing justice, loving mercy, and walking humbly with God.

A second order of sentiments are less exalted than these, but tend much to grace the human character, to contribute to our pleasures, and to fit us for our earthly duties. It includes *Firmness*, which gives us constancy under all, but particularly difficult circumstances—*Hope*, by which we are sustained under afflictions, and cheered on in the path of life—*Wonder*, by which we enjoy the contemplation of marvellous things, persons, and events, real and fictitious—the *Sentiment of the Beautiful*, which gives a taste for the finest productions of nature and art—the *Sentiment of the Ludicrous*, by which we enjoy every grotesque object, whimsical thought, and droll occurrence—and the *Impulse of Example*, by which we are led to imitate features of person, character, and conduct, which are set before us.

A third and lower order of sentiments comprehends *Self-esteem*, by which we are led to entertain respect and admiration for ourselves—the *Love of Approbation*, through which we become solicitous of the respect and

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291. What other orders of sentiments are cited?
292. Enumerate the lowest order.
293. Define the technicals.

admiration of others—and *Caution*, which prompts us to guard against evils which may or may not exist.

The last and lowest order of feelings embraces the *Love of Life*—the *Love of Food*—the *Desire of the Society of the Opposite Sex*—the *Love of Children*—the *Love of Friends*—the *Love of Places*—the *Disposition to Oppose and Defend*—the *Disposition to Resent and Destroy*—the *Disposition to Conceal*—the *Disposition to Acquire*—the *Disposition to Work*—and the *Disposition to Concentrate the Mind upon Particular Subjects of Reflection.*

The intellectual faculties operate and manifest themselves in certain modes, to which particular terms have been applied. The simplest operation of the Knowing and Reflecting Faculties is *Attention*, which is necessary to interrupt the flow of thought which is at all times passing through our minds, and to qualify us for observing and reasoning upon any thing brought before us. The next to which attention is a necessary preliminary, is *Perception*, by which our faculties take cognisance, each in its own way, of the objects of nature. The power which they have of remembering objects formerly presented to them, is *Memory*. When they operate without the things being present, and fill the mind with images as vivid as if actually seen, the act is called *Conception;* and the individuals whose minds are most active and lively in thus bodying forth unseen imagery, and giving it new arrangements and attributes, are said to manifest *Imagination.* That natural and almost involuntary operation of the intellect, by which one idea recalls another, in consequence of their being connected with each other, is termed *Association.* The imperfect and confused operation of the mental faculties in sleep, is the well-known phenomenon of *Dreaming*.

Each of the faculties, whether of the intellectual or the affective order, experiences gratification in being exercised. Every one of them has reference to some circumstances in our present state of existence, and a legitimate mode and

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294. Explain the italicised terms.

extent of operation. The knowing and reflecting faculties, when rightly directed, render us intelligent beings. The moral sentiments, when not carried to extravagance, give us those impressions of religion and virtue which constitute happiness in the present world, and prepare us for a better. The second order of sentiments furnish us with many innocent enjoyments, which are only reprehensible when pursued too eagerly. In the third order, we find inferior motives for virtue, in self-respect, and the desire of the good-will and approbation of our fellow-creatures, but which are highly useful where superior motives are insufficient. In their excess, these sentiments produce pride and vanity; the one being an undue satisfaction with ourselves, while the other is an undue anxiety for the praise of others. The fourth order contains propensities necessary for the preservation of the individual and the continuation of the species, but which are liable to great abuse, and, when abused, lead to many evils. Among good people, they are controlled by reason and religion, which present a view of the miserable consequences of their abuse, and inspire those moral sentiments, which prompt to opposite courses of conduct. There are none, however, who succeed in perfectly regulating these impulses; and hence all men are said to be naturally wicked. [Christianity reveals a Divine provision for a new creation of the moral nature of man, by which he may acquire the victory over himself, and a deliverance from this natural wickedness of the human heart.]

The sentiments can act singly, or in combinations. For instance, veneration may simply render us pious; self-esteem added, may make us very conceited of our own attainments in religion, and very contemptuous of the religious opinions of others. In the same way, an excessive love of approbation being united to benevolence, may make us ostentatious of our good deeds. So, also, a powerful feeling of resentment, in connection with conscientiousness, may produce great cruelty in punishment. The moral sentiments must act in purity, or they give us

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295. What reflections are suggested here?

little merit. The lower sentiments must also be trained to act in obedience to the moral sentiments, and under the direction of enlightened intellect, or they will lead us to do much evil. In general, our faculties remain in a state of tranquillity or insensibility, till something occurs to awake them; and hence many err more than others, merely in consequence of being in circumstances to have their lower sentiments more frequently roused.

An extended knowledge of the faculties of the mind, and their various powers and tendencies, is calculated to prove of great service to every one. It will fully satisfy all, that happiness (while in its highest form derivable from sources disclosed to us by our *religious faith*) mainly depends, in all its ordinary manifestations, upon the following conditions:—

First, The moderate exercise of the intellectual faculties in the business of life, and in the study of the works of nature—making them a source of enjoyment, without giving them greater labour than they are naturally fit for.

Second, The control of the inferior feelings, which, in their excess, produce crime and misery.

Third, A watchfulness over motives, guarding particularly against self-esteem and love of approbation, which often assume very plausible disguises, and also against undue resentments, which invariably lead to misery. And,

Fourth, A constant obedience to the moral sentiments, as those by which alone we can become amiable in the eyes of men, or acceptable to God. [These are taught in the Holy Scriptures, the only and all-sufficient rule of faith and practice.]

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296. What sources of happiness are pointed out?

THE END.

TO THE FRIENDS OF EDUCATION.

The publishers of this series of mathematical works by Professor CHARLES DAVIES, beg leave respectfully to ask of teachers and the friends of education a careful examination of these works. It is not their intention to commend, particularly, this Course of Mathematics to public favor; and especially, it is not their design to disparage other works on the same subjects. They wish simply to explain the leading features of this system of Text-Books—the place which each is intended to fill in a system of education—the general connection of the books with each other—and some of the advantages which result from the study of a uniform series of mathematical works.

It may, perhaps, not be out of place, first, to remark, that the author of this series, after graduating at the Military Academy, entered upon the duties of a permanent instructor in that institution in the year 1816, and was employed for the twenty following years in the departments of scientific instruction. At the expiration of that period he visited Europe, and had a full opportunity of comparing the systems of scientific instruction, both in France and England, with that which had been previously adopted at the Military Academy.

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The leading feature of the plan of this work is to teach the reading of figures
at is, so to train the mind that it shall, by the aid of the eye alone, catch in-
ntly the idea which any combination of figures is intended to express.
The method heretofore pursued has aimed only at presenting the combinations
means of our common language: this method proposes to present them pure-
through the arithmetical symbols, so that the pupil shall not be obliged to pause
every step and translate his conceptions into common language, and then re-
nslate them into the language of arithmetic.
For example, when he sees two numbers, as 4 and 8, to be added, he shall not
use and say, 4 and 8 are 12, but shall be so trained as to repeat 12 at once, as is
ways done by an experienced accountant. So, if the difference of these num-
rs is to be found, he shall at once say 4, and not 4 from 8 leaves 4. If he de-
es their product, he will say 32; if their quotient, 2: and the same in all simi-
cases.

FIRST LESSONS IN ARITHMETIC.

The First Lessons in Arithmetic begin with counting, and advance step by step
rough all the simple combinations of numbers. In order that the pupil may be
pressed with the fact that numbers express a collection of units, or things of
e same kind, the unit, in the beginning, is represented by a star, and the child
ould be made to count the stars in all cases where they are used. Having once
ed in the mind a correct impression of numbers, it was deemed no longer
cessary to represent the unit by a symbol; and hence the use of the star was
continued. In adding 1 to each number from 1 to 10, we have the first ten
mbinations in arithmetic. Then by adding 2 in the same way, we have the
cond ten combinations, and so on. Each ten combinations is arranged in a
parate lesson, throughout the four ground rules, and each is illustrated either
unit marks or a simple example. Thus the four hundred elementary combi-
tions are presented, in succession, in forty lessons,—a plan not adopted in any
ner elementary book.

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This work begins with the simplest combination of numbers, and contains all
at is supposed to be necessary for the average grade of classes in schools. It
strictly scientific and entirely practical in its plan. Each idea is first presented
the mind either by an example or an illustration, and then the principle, or
stract idea, is stated in general terms. Great care has been taken to attain
nplicity and accuracy in the definitions and rules, and at the same time so to
ame them as to make them introductory to the higher branches of mathematical
ence. No definition or rule is given until the mind of the pupil has been
ought to it by a series of simple inductions, so that mental training may begin
h the first intellectual efforts in numbers

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Those who are conversant with the preparation of elementary text-books, have experienced the difficulty of adapting them to the wants which they are intended to supply. The institutions of instruction are of all grades from the college to the district school, and although there is a wide difference between the extremes, the level in passing from one grade to the other is scarcely broken. Each of these classes of seminaries requires text-books adapted to its own peculiar wants; and if each held its proper place in its own class, the task of supplying suitable text-books would not be so difficult. An indifferent college is generally inferior, in the system and scope of instruction, to a good academy or high-school; while the district-school is often found to be superior to its neighboring academy.

Although, therefore, the University Arithmetic and the Practical Geometry and Mensuration, have been classed among the books appropriate for academies, they may no doubt be often advantageously studied in the common-school; so also with the Algebra and Elementary Geometry. The Practical Geometry and Mensuration, containing so much practical matter, can hardly fail to be a useful and profitable study.

DAVIES' UNIVERSITY ARITHMETIC.

The scholar in commencing this work, is supposed to be familiar with the operations in the four ground rules, which are fully taught both in the First Lessons and in the School Arithmetic. This being premised, the language of figures, which are the representatives of numbers, is carefully taught, and the different significations of which the figures are susceptible, depending on the places in which they are written, are fully explained. It is shown, for example, that the simple numbers in which the unit increases from right to left according to the scale of tens, and the Denominate or Compound Numbers, in which it increases according to a different scale, belong in fact to the same class of numbers, and that both may be treated under a common set of rules. Hence, the rules for Notation, Addition, Subtraction, Multiplication, and Division, have been so constructed as to apply equally to all numbers. This arrangement is a new one, and is deemed an essential improvement in the science of numbers

In developing the properties of numbers, from their elementary to their highest combinations, great labor has been bestowed on classification and arrangement. It has been a leading object to present the entire subject of arithmetic as forming

ries of dependent and connected propositions; so that the pupil, while ac-
ing useful and practical knowledge, may at the same time be introduced to
e beautiful methods of exact reasoning which science alone can teach.
reat care has been taken to demonstrate fully all the rules, and to explain the
on of every process, from the most simple to the most difficult. The demon-
tion of the rule for the division of fractions, on page 147, is new and consid-
l valuable.
he properties of the 9's, explained at page 93, and the demonstration of the
ground rules by means of those properties, are new in their present form,
are thought worthy of special attention.
the preparation of the work, another object has been kept constantly in
r; viz., to adapt it to the business wants of the country. For this purpose,
h pains have been bestowed in the preparation of the articles on Weights
Measures, foreign and domestic—on Banking, Bank Discount, Interest, Coins
Currency, Exchanges, Book-keeping, &c. In short, it is a full treatise on
subject of Arithmetic, combining the two characteristics of a scientific and
tical work.

Recommendation from the Professors of the Mathematical Department of the United States Military Academy

the distinctness with which the various definitions are given—the clear and
tly mathematical demonstration of the rules—the convenient form and well-
sen matter of the tables, as well as in the complete and much-desired appli-
on of all to the business of the country, the "University Arithmetic" of
f. Davies is superior to any other work of the kind with which we are ac-
inted. These, with the many other improvements introduced by the ad-
able scientific arrangement and treatment of the whole subject, and in par-
lar those of the *generalization* of the four ground rules, so as to include
mple and denominate" numbers under the same head, and the very plain
onstration of the rule for the division of fractions—both of which are, to us,
inal—make the work an invaluable one to teachers and students who are de-
us to teach or study arithmetic as a science as well as an art.

(Signed,) D. H. MAHAN, Prof. Engineering.
W. H. C. BARTLETT, Prof. Nat. Phil.
A. E. CHURCH, Prof. Mathematics.

United States Military Academy, Jan. 18, 1847.

PRACTICAL GEOMETRY AND MENSURATION.

he design of this work is to afford schools and academies an Elementary
xt-Book of a practical character. The introduction into our schools, within
last few years, of the subjects of Natural Philosophy, Astronomy, Mineralo-
Chemistry, and Drawing, has given rise to a higher grade of elementary
dies; and the extended application of the mechanic arts calls for additional
ormation among practical men. In this work all the truths of Geometry are
de accessible to the general reader, by omitting the demonstrations altogether,
l relying for the impression of each particular truth on a pointed question and
illustration by a diagram. In this way it is believed that all the important
perties of the geometrical figures may be learned in a few weeks; and after
se properties have been once applied, the mind receives a conviction of their
th little short of what is afforded by rigorous demonstration. The work is
ided into seven books, and each book is subdivided into sections.
Book I., the properties of the geometrical figures are explained by questions
illustrations.

In Book II. are explained the construction and uses of the various scales; and also the construction of geometrical figures. It is, as its title imports, Practical Geometry.

Book III. treats of Drawing. Section I., of the Elements of the Art; Section II., of Topographical Drawing; and Section III., of Plan Drawing.

Book IV. treats of Architecture—explaining the different orders, both by descriptions and drawings.

Book V. contains the application of the principles of Geometry to the Mensuration of Surfaces and Solids. A separate rule is given for each case, and the whole is illustrated by numerous and appropriate examples.

Book VI. contains the application of the preceding Books to Artificers' and Mechanics' work. It contains full explanations of all the scales—the uses to which they are applied—and specific rules for the calculations and computations which are necessary in practical operations.

Book VII. is an introduction to Mechanics. It explains the nature and properties of matter, the laws of motion and equilibrium, and the principles of all the simple machines.

ELEMENTARY ALGEBRA.

This work is intended to form a connecting link between Arithmetic and Algebra, and to unite and blend, as far as possible, the reasoning on numbers with the more abstract method of analysis. It is intended to bring the subject of Algebra within the range of our common schools, by giving to it a practical and tangible form. It begins with an introduction, in which the subject is first treated mentally, in order to accustom the mind of the pupil to the first processes; after which, the system of instruction assumes a practical form. The definitions and rules are as concise and simple as they can be made, and the reasonings are as clear and concise as the nature of the subject will admit. The strictest scientific methods are always adopted, for the double reason, that what is learned should be learned in the right way, and because the scientific methods are generally the most simple.

ELEMENTARY GEOMETRY.

This work is designed for those whose education extends beyond the acquisition of facts and practical knowledge, but who have not the time to go through a full course of mathematical studies. It is intended to present the striking and important truths of Geometry in a form more simple and concise than is adopted in Legendre, and yet preserve the exactness of rigorous reasoning. In this system, nothing has been omitted in the chain of exact reasoning, nothing has been taken for granted, and nothing passed over without being fully demonstrated The work also contains the applications of Geometry to the Mensuration of Surfaces and Solids.

SURVEYING.

In this work it was the intention of the author to begin with the very elements of the subject, and to combine those elements in the simplest manner, so as to render the higher branches of Plane Surveying comparatively easy. All the instruments needed for plotting have been carefully described, and the uses of those required for the measurement of angles are fully explained. The Conventional Signs adopted by the Topographical Bureau, and which are now used by the United States Engineers in all their charts and maps, are given in full. An account is also given of the manner of surveying the public lands; and although the method is simple, it has nevertheless been productive of great results. The work also contains a Table of Logarithms—a Table of Logarithmic Sines—a Traverse Table, and a Table of Natural Sines—being all the Tables necessary for Practical Surveying

The Collegiate Course.

I. DAVIES' BOURDON'S ALGEBRA.
II. DAVIES' LEGENDRE'S GEOMETRY AND TRIGONOMETRY.
II. DAVIES' ANALYTICAL GEOMETRY.
V. DAVIES' DESCRIPTIVE GEOMETRY.
V. DAVIES' SHADES, SHADOWS, AND PERSPECTIVE.
'I. DAVIES' DIFFERENTIAL AND INTEGRAL CALCULUS.

The works embraced under the head of the "Collegiate Course," ere originally prepared as text-books for the use of the Military cademy at West Point, where, with a single exception, they are ll used. Since their introduction into many of the colleges of e country, they have been somewhat modified, so as to meet the ants of collegiate instruction. The general plan on which these orks are written, was new at the time of their appearance. Its ain feature was to unite the logic of the French School of athematics with the practical methods of the English, and the o methods are now harmoniously blended in most of our systems scientific instruction.

The introduction of these works into the colleges was for a ng time much retarded, in consequence of the great deficiency in e courses of instruction in the primary schools and academies: d this circumstance induced Professor Davies to prepare his lementary Course.

The series of works here presented, form a full and complete urse of mathematical instruction, beginning with the first combinations of arithmetic, and terminating in the higher applications the Differential Calculus. Each part is adapted to all the ners. The Definitions and Rules in the Arithmetic, have ference to those in the Elementary Algebra, and these to similar es in the higher books. A pupil, therefore, who begins this urse in the primary school, passes into the academy, and then o the college, under the very same system of scientific instruction.

The methods of teaching are all the same, varied only by the ture and difficulty of the subject. He advances steadily from e grade of knowledge to another, seeing as he advances the con ction and mutual relation of all the parts: and when he reaches end of his course, he finds indeed, that "science is but know re reduced to order."

DAVIES' BOURDON.

The Treatise on Algebra by M. Bourdon, is a work of singular excellence and merit. In France it is one of the leading text-books. Shortly after its first publication it passed through several editions, and has formed the basis of every subsequent work on the subject of Algebra.

The original work is, however, a full and complete treatise on the subject of Algebra, the later editions containing about eight hundred pages octavo. The time given to the study of Algebra in this country, even in those seminaries where the course of mathematics is the fullest, is too short to accomplish so voluminous a work, and hence it has been found necessary either to modify it, or to abandon it altogether. The Algebra of M. Bourdon, however, has been regarded only as a standard or model, and it would perhaps not be just to regard him as responsible for the work in its present form.

In this work are united the scientific discussions of the French with the practical methods of the English school, so that theory and practice, science and art, may mutually aid and illustrate each other. A great variety of examples have also been added in the late editions.

DAVIES' LEGENDRE.

Legendre's Geometry has taken the place of Euclid, to a great extent, both in Europe and in this country. In the original work the propositions are not enunciated in general terms, but with reference to, and by the aid of, the particular diagrams used for the demonstrations. It was supposed that this departure from the method of Euclid had been generally regretted, and among the many alterations made in the original work, to adapt it to the systems of instruction in this country, that of enunciating the propositions in general terms should be particularly named; and this change has met with universal acceptance.

To the Geometry is appended a system of Mensuration of Planes and Solids—a full treatise on Plane and Spherical Trigonometry—and a table of Logarithms, and Logarithmic Sines, Tangents, and Secants. The whole forms a complete system of Geometry with its applications to Trigonometry and Mensuration, together with the necessary tables.

ANALYTICAL GEOMETRY.

This work embraces the investigation of the properties of geometrical figures by means of analysis. It commences with the elementary principles of the science, discusses the Equation of the Straight Line and Circle—the Properties of the Conic Sections—the Equation of the Plane—the Positions of Lines in Space, and the Properties of Surfaces.

DESCRIPTIVE GEOMETRY.

Descriptive Geometry is intimately connected with Architecture and Civil Engineering, and affords great facilities in all the operations of Construction.

As a mental discipline, the study of it holds the first place among the various branches of Mathematics.

SHADES, SHADOWS, AND PERSPECTIVE.

This work embraces the various applications of Descriptive Geometry to Drawing and Linear Perspective.

DIFFERENTIAL AND INTEGRAL CALCULUS.

This treatise on the Differential and Integral Calculus, was intended to supply the higher seminaries of learning with a text-book on that branch of science. It is a work after the French methods of teaching, and in which the notation of the French school is adopted.

NATURAL AND EXPERIMENTAL PHILOSOPHY
FOR SCHOOLS AND ACADEMIES,
BY R. G. PARKER, A.M.

PRINCIPAL OF THE JOHNSON GRAMMAR SCHOOL, BOSTON, AUTHOR OF AIDS TO ENGLISH COMPOSITION, ETC., ETC.

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Embracing the Elements of the Science. Illustrated with numerous engravings. Designed for young beginners. Price 38 cts.

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Reading books should be used in schools for the double object of teaching the child to read, and storing his mind with pleasant and useful ideas.

The form of instruction by dialogue, being the simplest, has been adopted—and by means of the simple question and the appropriate answer, a general view of the laws of the physical universe has been rendered so intelligible, as to be easily understood by children who are able to read intelligibly.

It is confidently believed that this book will form an important era in the progress of common-school education

PARKER'S COMPENDIUM OF NATURAL AND EXPERIMENTAL PHILOSOPHY.

Embracing the Elementary principles of *Mechanics, Hydrostatics, Hydraulics, Pneumatics, Acoustics, Pyronomics, Optics, Astronomy, Galvanism, Magnetism, Electro-Magnetism, Magneto-Electricity,* with a description of the *Steam* and *Locomotive Engines.* Illustrated by numerous diagrams. Price $1.00.

The use of school apparatus for illustrating and exemplifying the principles of Natural and Experimental Philosophy, has, within the last few years, become so general as to render necessary a work which should combine, in the same course of instruction, the theory, with a full description of the apparatus necessary for illustration and experiment.

The work of Professor Parker, it is confidently believed, fully meets that requirement. It is also very full in the general facts

which it presents—clear and concise in its style, and entirely scientific and natural in its arrangement. The following features will, it is hoped, commend the work to public favor.

1. It is adapted to the *present state* of natural science; embraces a wider field, and contains a greater amount of information on the respective subjects of which it treats, than any other elementary treatise of its size.

2. It contains an engraving of *the Boston School set of philosophical apparatus;* a description of the instruments, and an account of many experiments which can be performed by means of the apparatus.

3. It is enriched by a representation and a description of the *Locomotive* and the *Stationary Steam Engines*, in their latest and most approved forms.

4. Besides embracing a copious account of the principles of Electricity and Magnetism, its value is enhanced by the introduction of the science of Pyronomics, together with the new science of Electro-Magnetism and Magneto-Electricity.

5. It is peculiarly adapted to the convenience of study and of recitation, by the figures and diagrams being first placed side by side with the illustrations, and then repeated on separate leaves at the end of the volume. The number is also given, where each principle may be found, to which allusion is made throughout the volume.

6. It presents the most important principles of science in a larger type; while the deductions from these principles, and the illustrations, are contained in a smaller letter. Much useful and interesting matter is also crowded into notes at the bottom of the page. By this arrangement, the pupil can never be at a loss to distinguish the parts of a lesson which are of primary importance; nor will he be in danger of mistaking theory and conjecture for fact.

7. It contains a number of original illustrations, which the author has found more intelligible to young students than those which he has met elsewhere.

8. Nothing has been omitted which is usually contained in an elementary treatise.

9. A full description is given of the Magnetic Telegraph, and the principles of its construction are fully explained.

10. For the purpose of aiding the teacher in conducting an examination through an entire subject, or indeed, through the whole book, if necessary, all the diagrams have been repeated at the end of the work, and questions proposed on the left-hand page immediately opposite. This arrangement will permit the pupil to use the figure, in his recitation, if he have not time to make it on the black-board, and will also enable him to review several lessons and recall all the principles by simply reading the questions, and analyzing the diagrams.

Parker's Natural Philosophy.

From the Wayne County Whig.

After a careful examination of this work, we find that it is well calculated for the purpose for which it is intended, and better adapted to the state of natural science at the present time, than any other similar production with which we are acquainted. The design of the author, in the preparation of this work, was to present to the public an elementary treatise unencumbered with matter that is not intimately connected with this science, and to give a greater amount of information on the respective subjects of which it treats, than any other school-book of an elementary character. The most remarkable feature in the style of this work is its extreme brevity. In the arrangement of the subject and the manner of presenting it, there are some peculiarities which are, in our opinion, decided improvements. The more important principles of this interesting science are given in a few words, and with admirable perspicuity, in a larger type; while the deductions from these principles, and the illustrations are contained in a smaller letter. Much useful and interesting matter is also given in notes at the bottom of the page.

This volume is designed expressly to accompany the *Boston School Set of Philosophical Apparatus;* but the numerous diagrams with which it is illustrated, are so well executed and so easily understood, that the assistance of the Apparatus is hardly *necessary* to a thorough knowledge of the science. The trustees of the Lyons Union School having recently procured a complete set of the above Apparatus, this work will now be used as a text-book in that institution.

LEICESTER ACADEMY, *April* 12, 1848.

MESSRS. A. S. BARNES & Co.:

Sirs:—I have examined Parker's Natural Philosophy, and am much pleased with it. I think I shall introduce it into the academy the coming term. It seems to me to have hit a happy medium between the too simple and the too abstract. The notes containing facts, and showing the reasons of many things that are of common occurrence in every-day life, seem to me to be a valuable feature of the work.

Very respectfully, yours, B. A. SMITH.

From the New York Evening Post.

Professor Parker's book embraces the latest results of investigation on the subjects of which it treats. It has a separate title for the laws of heat, or Pyronomics, which have been lately added to the list of sciences, as well as electro magnetism and magneto-electricity. The matter is well arranged, and the style of statement clear and concise. The figures and diagrams are placed side by side with the text they illustrate, which is greatly for the convenience of the student. We cheerfully commend the book to the favorable attention of the public.

From the Albany Spectator.

This is a school-book of no mean pretensions and of no ordinary value. It is admirably adapted to the present state of natural science; and besides containing engravings of the Boston school set of philosophical apparatus, embodies more information on every subject on which it treats than any other elementary work of its size that we have examined. It abounds with all the necessary helps in prosecuting the study of the science, and as its value becomes known it cannot fail to be generally adopted as a text-book.

From the Newark Daily Advertiser.

A work adapted to the *present* state of natural science is greatly needed in all our schools, and the appearance of one meeting all ordinary wants must be hailed with pleasure by those who feel an interest in the cause of education. Mr. Parker's work embraces a wider field, and contains a greater amount of information on the respective subjects of which it treats, than any other elementary treatise of its size, and is rendered peculiarly valuable by the introduction of the science of Pyronomics, together with the new sciences of Electro-Magnetism and Magneto Electricity. We have seldom met with a work so well adapted to the convenience of study and recitation, and regard as highly worthy of commendation the care which the author has taken to prevent the pupil from mistaking theory and conjecture for fact. We predict for this valuable and beautifully printed w the utmost success.

From the New York Courier and Enquirer

"A School Compendium of Natural and Experimental Philosophy," by Richard Green Parker, has just been issued by Barnes & Co. Mr. Parker has had a good deal of experience in the business of practical instruction, and is, also, the author of works which have been widely adopted in schools. The present volume strikes us as having very marked merit, and we cannot doubt it will be well received.

NEW YORK, *May*, 1848.

MESSRS. A. S. BARNES & CO.:

Gent.:—I have no hesitation in saying that Parker's Natural Philosophy is the most valuable elementary work I have seen: the arrangement of the subjects and the clearness of the definitions render it an excellent adjunct to a teacher. For the last seven years I have used it in various schools as a text-book for my lectures on Natural Philosophy, and am happy to find that in the new edition much important matter is added, more especially on the subjects of Electricity and Electro-Magnetism.

With respect, Gentlemen,
Your obedient servant,
GILBERT LANGDON HUME,
Teacher of Natural Philosophy and Mathematics in N. Y. city.

NEW YORK, *May* 2, 1848.

We have used Parker's Compend of Natural Philosophy for many years, and consider it an excellent work on the various topics of which it treats.

Yours, &c. FORREST & McELLIGOTT,
Principals of the Collegiate School.

From the Lynchburg Virginian.

The volume before us strikes us as containing more to recommend it than any one of its class with which we are acquainted. It is adapted to the *present state* of natural science; embraces a wider field, and contains a greater amount of information on the respective subjects of which it treats, than any other elementary treatise of its size. It contains descriptions of the steam-engine, stationary and locomotive, and of the magnetic telegraph. It embraces a copious account of the principles of electricity and magnetism, under all their modifications, and is embellished by a vast number of illustrations and diagrams. There is appended a series of questions for examination, copious and pertinent

ROADS AND RAILROADS.

A MANUAL OF ROAD-MAKING:

Comprising the principles and practice of the Location, Construction, and Improvement of ROADS, (common, macadam, paved plank, &c.,) and RAILROADS. By W. M. GILLESPIE, A. M., Professor of Civil Engineering in Union College. Price $1.50.

Recommendation from Professor Mahan.

I have very carefully looked over Professor Gillespie's Manual of Road-Making. It is, in all respects, the best work on this subject with which I am acquainted; being, from its arrangement, comprehensiveness and clearness, equally adapted to the wants of Students of Civil Engineering, and the purposes of persons in any way engaged in the construction or supervision of roads. The appearance of such a work, twenty years earlier, would have been a truly national benefit, and it is to be hoped that its introduction into our seminaries may be so general as to make a knowledge of the principles and practice of this branch of engineering, as popular as is its importance to all classes of the community.

(Signed,)

D. H. MAHAN,
Professor of Civil Engineering in the Military Academy of the United States.

From a Report of a Committee of the American Institute.

This work contains in a condensed form, all the principles, both ancient and modern, of this most important art; and almost every thing useful in the great mass of writers on this subject. . . . . Such a work as this performs a great service for those who are destined to construct roads—by showing not only what ought to be done, but what ought not to be done; thus saving immense outlay of money, and loss of time in experiments. . . . . The committee therefore, recommend it to the public.

From the American Railroad Journal.

The views of the author are sound and practical, and should be read by the people throughout the entire length and breadth of the land. . . . We recommend this Manual to the perusal of every tax-payer for road-making, and to the young men of the country, as they will find useful information in relation to each department of road-making, which will surely be useful to them in after-life.

From Silliman's American Journal of Science.

If the well-established principles of Road-Making, which are so plainly set forth in Prof. Gillespie's valuable work, and so well illustrated, could be once put into general use in this country, every traveller would bear testimony to the fact that the author is a great public benefactor.

From the Journal of the Franklin Institute.

This small volume contains much valuable matter, derived from the best authorities, and set forth in a clear and simple style. For the want of information which is contained in this Manual, serious mistakes are frequently made, and roads are badly located and badly constructed by persons ignorant of the true

principles which ought to govern in such cases. By the extensive circulation of such books as that now before us, and the imparting of sound views on the subject to the students of our collegiate institutions, we may hope for a change for the better in this respect.

From the Albany Cultivator.

The author of this work has supplied a desideratum which has long existed. Perhaps there is no subject on which information is more needed by the country in general than that of Road-Making. Prof. Gillespie has taken up the subject in a proper manner, beginning the work at the right place, and prosecuting it in systematic order to its completion.

From the New York Tribune.

It would astonish many "path-masters" to see how much they don't know with regard to the very business they have considered themselves such adepts in. Yet all is so simple, so lucid, so straight-forward, so manifestly true, that the most ordinary and least instructed mind cannot fail to profit by it. We trust this useful and excellent volume may find its way into every village library if not into every school library, as well as into the hands of every man interested in road-making. Its illustrations are very plain and valuable, and we cannot doubt that the work will be a welcome visiter in many a neighborhood, and that bad roads will vanish before it.

From the Newark Daily Advertiser.

This elaborate and admirable work combines in a systematic and symmetrical form the results of an engineering experience in all parts of the Union, and of an examination of the great roads of Europe, with a careful digestion of all accessible authorities. The six chapters into which it is divided comprehend a methodical treatise upon every part of the whole subject; showing what roads ought to be in the vital points of direction, slopes, shape, surface, and cost, and giving methods of performing all the necessary measurements of distances, directions, and heights, without the use of any instruments but such as any mechanic can make, and any farmer use. Bridges, Railroads, and City Streets are also treated of at length and with good sense.

From the Vermont Chronicle.

To selectmen and others who may have any thing to do with these improvements, we would earnestly recommend the book named above. The author is a man of science, (Professor of Civil Engineering at Union College,) and his work embraces a full discussion of both the principles and practice of Road-Making A little study of this work may often lead to results of importance to whole towns and counties.

From the Home Journal.

The author of this book holds a quill so skilful and dainty in light literature, that we were not prepared with laurels to crown him for a scientific work; but we see, by the learned critics, that this fruit of his study of his profession as an engineer, is very worthy of high commendation, and a valuable addition to the useful literature of the day.

MRS. EMMA WILLARD'S

SERIES OF SCHOOL HISTORIES AND CHARTS.

I. WILLARD'S HISTORY OF THE UNITED STATES, OR REPUBLIC OF AMERICA. 8vo. Price $1.50.

II. WILLARD'S SCHOOL HISTORY OF THE UNITED STATES.

III. WILLARD'S AMERICAN CHRONOGRAPHER, $1.00.
A CHART OF AMERICAN HISTORY.

I. WILLARD'S UNIVERSAL HISTORY IN PERSPECTIVE. $1.50.

II. WILLARD'S TEMPLE OF TIME, $1.25.
A CHART OF UNIVERSAL HISTORY

WILLARD'S
HISTORY OF THE UNITED STATES.

The large work is designed as a Text-Book for *Academies* and *Female Seminaries:* and also for *District School* and *Family Libraries.* The small work being an *Abridgment* of the same, is designed as a *Text-Book for Common Schools.* The originality of the plan consists in dividing the time into *periods*, of which the beginnings and terminations are marked by important events; and constructing *a series of maps illustrating the progress of the settlement of the country, and the regular advances of civilization.* The *Chronographic Chart*, gives by simple inspection, a view of the divisions of the work, and the events which mark the *beginning* and *termination* of each period into which it is divided. A *full chronological table* will be found, in which all the events of the History are arranged in the order of time. There is appended to the work the *Constitution of the United States*, and a series of questions adapted to each chapter, so that the work may be used in schools and for private instruction.

The Hon. Daniel Webster says, of an early edition of the above work, in a letter to the author, "*I keep it near me, as a Book of Reference, accurate in facts and dates.*"

WILLARD'S AMERICAN CHRONOGRAPHER,

DESIGNED TO ACCOMPANY WILLARD'S HISTORY OF THE UNITED STATES.

To measure time by space is universal among civilized nations, and as the hours, and minutes, and seconds of a clock measure the time of a day, so do the centuries, tens, and single years of this Chronographer, measure the time of American History. A general knowledge of chronology is as indispensable to history, as a general knowledge of latitude and longitude is to geography. But to learn single dates, *apart* from a general plan of chronology addressed to the eye, is as useless as to learn latitudes and longitudes without reference to a map. The eye is the only medium of permanent impression. The essential point in a date, is to know the *relative* place of an event, or how it stands in time compared with other important events. The scholar in the school-room, or the gentleman in his study, wants such a *visible plan of time* for the study of history, the same as he wants the visible plan of space, viz., a map for the study of geography, or of books of travels. Such is the object of *Willard's Chronographer of American History.*

Extract from a Report of the Ward School Teachers' Association of the City of New York.

The Committee on Books of the Ward School Association respectfully report:

That they have examined Mrs. Willard's History of the United States with peculiar interest, and are free to say, that it is in their opinion decidedly the best treatise on this interesting subject that they have seen. * *

As a school-book, its proper place is among the first. The language is remarkable for simplicity, perspicuity, and neatness; youth could not be trained to a better taste for language than this is calculated to impart. The history is so written as to lead to geographical examinations, and impresses by practice the habit to read history with maps. It places at once, in the hands of American youth, the history of their country from the day of its discovery to the present time, and exhibits a clear arrangement of all the great and good deeds of their ancestors, of which they now enjoy the benefits, and inherit the renown. The struggles, sufferings, firmness, and piety of the first settlers are delineated with a masterly hand.

The gradual enlargement of our dominions, and the development of our national energies, are traced with a minute accuracy, which the general plan of the work indicates.

The events and achievements of the Revolution and of the last war, are brought out in a clear light, and the subsequent history of our national policy and advancement strikingly portrayed, without being disfigured by that tinge

of party bias which is so difficult to be guarded against by historians of their own times.

The details of the discovery of this continent by Columbus, and of the early settlements by the Spaniards, Portuguese, and other European nations, are all of essential interest to the student of American history, and will be found sufficiently minute to render the history of the continent full and complete. The different periods of time, together with the particular dates, are distinctly set forth with statistical notes on the margin of each page,—and these afford much information without perusing the pages.

The maps are beautifully executed, with the locality of places where particular events occurred, and the surrounding country particularly delineated. These are admirably calculated to make lasting impressions on the mind.

The day has now arrived when every child should be acquainted with the history of his country; and your Committee rejoice that a work so full and clear can be placed within the reach of every one.

The student will learn, by reading a few pages, how much reason he has to be proud of his country—of its institutions—of its founders—of its heroes and statesmen: and by such lessons are we not to hope that those who come after us will be instructed in their duties as citizens, and their obligations as patriots?

Your Committee are anxious to see this work extensively used in all the schools in the United States.

(Signed,)

SENECA DURAND,
EDWARD McELROY,
JOHN WALSH.

The Committee would respectfully offer the following resolution:

Resolved, That Mrs. Emma Willard's History of the United States be adopted by this Association, and its introduction into our schools earnestly recommended.

At a meeting of the Board of the Ward School Teacners' Association, January 20th, 1847, the above Resolution was adopted.—(Copied from the Minutes.)

From the Boston Traveller.

We consider the work a remarkable one, in that it forms the best book for general reading and reference published, and at the same time has no equal, in our opinion, as a text-book. On this latter point, the profession which its author has so long followed with such signal success, rendered her peculiarly a fitting person to prepare a text-book. None but a practical teacher is capable of preparing a *good* school-book; and as woman has so much to do in forming our early character, why should her influence cease at the fireside—why not encourage her to exert her talents still, in preparing school and other books for after years? No hand can do it better.

The typography of this work is altogether in good taste.

From the Cincinnati Gazette.

MRS. WILLARD'S SCHOOL HISTORY OF THE UNITED STATES.—It is one of those rare things, a good school-book; infinitely better than any of the United States Histories fitted for schools, which we have at present. It is quite full enough, and yet condensed with great care and skill. The style is clear and simple—Mrs. Willard having avoided those immense Johnsonian words which Grimshaw and other writers for children love to put into their works, while, at the same time there is nothing of the pap style about it. The arrangement is excellent,

the chapters of a good length; every page is dated, and a marginal index makes reference easy. But the best feature in the work is its series of maps; we have the country as it was when filled with Indians; as granted to Gilbert; as divided at the time the Pilgrims came over; as apportioned in 1643; the West while in possession of France; the Atlantic coast in 1733; in 1763; as in the Revolution, with the position of the army at various points; at the close of the Revolutionary War; during the war of 1812-15; and in 1840: making eleven most excellent maps, such as every school history should have. When we think of the unintelligible, incomplete, badly written, badly arranged, worthless work of Grimshaw which has been so long used in our schools, we feel that every scholar and teacher owes a debt of gratitude to Mrs. Willard. Miss Robins has done for English History, what Mrs. Willard has now done for American, and we trust these two works will be followed by others of as high or higher character. We recommend Mrs. Willard's work as better than any we know of on the same subject; not excepting Bancroft's abridgment. This work, followed by the careful reading of Mr. Bancroft's full work, is all that would be needed up to the point where Bancroft stops; from that point, Pitkin and Marshall imperfectly supply the place, which Bancroft and Sparks will soon fill.

From the United States Gazette.

Mrs. Willard is well known throughout the country as a lady of high attainments, who has distinguished herself as the Principal of Female Academies, that have sent abroad some of the most accomplished females of the land.

The plan of the authoress is to divide the time into periods, of which the beginning and the end are marked by some important event, and then care has been taken to make plain the events of intermediate periods. The style is clear, and there appears no confusion in the narrative. In looking through the work, we do not discover that the author has any early prejudices to gratify. The book, therefore, so far as we have been able to judge, may be safely recommended as one of great merit, and the maps and marginal notes, and series of questions, give additional value to the work.

From the Newburyport Watchman.

An Abridged History of the United States: By Emma Willard.—We think we are warranted in saying, that it is better adapted to meet the wants of our schools and academies in which history is pursued, than any other work of the kind now before the public.

The style is perspicuous and flowing, and the prominent points of our history are presented in such a manner as to make a deep and lasting impression on the mind.

We could conscientiously say much more in praise of this book, but must content ourselves by heartily commending it to the attention of those who are anxious to find a good text-book of American history for the use of schools.

From the Albany Evening Journal.

Willard's United States.—This work is well printed on strong white paper, and is bound in a plain substantial manner—all-important requisites in a school-book. The text is prepared with equal skill and judgment. The memory of the youthful student is aided by a number of spirited illustrations—by no means unimportant auxiliaries—while to lighten the labors of the teacher, a series of questions is adapted to each chapter. Nor is its usefulness limited to the school-room As a book of reference for editors, lawyers, politicians, and others, where dates and facts connected with every important event in American History may be readily found, this little book is truly valuable.

WILLARD'S
UNIVERSAL HISTORY IN PERSPECTIVE.

ILLUSTRATED WITH MAPS AND ENGRAVINGS.

THIS WORK IS ARRANGED IN THREE PARTS, VIZ:

ANCIENT, MIDDLE, AND MODERN HISTORY.

1. ANCIENT HISTORY is divided into six periods—comprising events from the Creation, to the Birth of our Saviour.

2. MIDDLE HISTORY, into five periods,—from the Christian Era, to the Discovery of America.

3. MODERN HISTORY, into nine periods,—from the Discovery of America, to the present time. Each period marked by some important event and illustrated by maps or engravings.

The following resolution was offered and adopted at a meeting of the Ward School Teachers' Association of the City of New York, January 20th, 1847.

Resolved, That the Ward School Teachers' Association of New York considers Willard's Universal History as a book essentially adapted to the higher classes of schools on account of its vivacity, lucidness, and intelligent mode of arrangement, of dates and questions, and that such a work has long been wanted, and as such will endeavor to introduce it into their respective schools, and warmly recommend it to public patronage.

Extract of a Letter from Mr. Elbridge Smith, late Principal of the English High School of Worcester, Mass.

I have recently introduced "Willard's Universal History in Perspective," into the school under my care. I am much pleased with it, and think it superior to any other work of the kind.

(Signed,) ELBRIDGE SMITH.

Worcester, June 5, 1847.

From Professor Charles B. Haddock of Dartmouth College, and School Commissioner of the State of New Hampshire.

I am acquainted with Mrs. Willard's Histories, and entertain a high opinion of them. They are happily executed, and worthy of the long experience and eminent character of their author.

(Signed,) CHARLES B. HADDOCK.

Dartmouth College, Hanover, Dec. 11, 1846.

FULTON & EASTMAN'S PENMANSHIP,

Illustrated and expeditiously taught by the use of a series of Chirographic Charts, a Key, and a set of School Writing-Books, appropriately ruled.

I.

CHIROGRAPHIC CHARTS,

IN TWO NUMBERS. (Price 5.00.)

Chart No. 1, EMBRACES PRIMARY EXERCISES, AND ELEMENTARY PRINCIPLES IN WRITING.

Chart No. 2, EMBRACES ELEMENTARY PRINCIPLES FOR CAPITALS COMBINED, AND ELEMENTARY PRINCIPLES FOR SMALL LETTERS COMBINED.

II.

KEY TO CHIROGRAPHIC CHARTS;

Containing directions for the position at the desk, and manner of holding the pen.—Also for the exact forms and proportions of letters, with Rules for their execution. (Price 25 cents.)

III.

SCHOOL WRITING-BOOKS.

IN FOUR NUMBERS. (Price 12½ cents each.)

From the Trustees of the Union School, Lyons, N. Y.

The undersigned, trustees of the Union District School of the town of Lyons, take this method of expressing their approval of "Fulton's Principles of Penmanship." They have seen the system in operation, during the past year, in the school with which they are connected, and are fully satisfied of its great superiority over all other systems heretofore used. The "Chirographic Charts," upon which are drawn in large size the different letters and parts of the letters of the alphabet, proportioned in accordance with the rules laid down by the author for the formation of each letter, and which, when suspended, can be seen from all parts of a school-room of ordinary size, they regard as an especial improvement upon, and advantage over, other modes of teaching this art. While the labor of the teacher is by this means lightened a hundredfold, from the fact that the directions and rules thus illustrated, can be explained to a whole class at once, the benefit to the scholar is proportionally increased. The charts being made the property of the district, a uniformity is established in this branch of instruction, and the continual changes in books and methods of teaching, which have heretofore given occasion to so much just complaint on the part of parents and guardians, and which have been so prejudicial to the pupil, are entirely avoided.

The brief space necessarily allotted to a notice of this kind, will not permit the undersigned to say all they might say with truth in praise of Mr. F.'s system of instruction. They therefore conclude with the remark that it meets their entire approbation, and they cordially commend it to the favorable notice of the friends of education generally, and would recommend its adoption by academies and common schools in this and in other states.

A. L. BEAUMONT
ELI JOHNSON,
DE WITT PARSHALL.

Dated Lyons, N. Y., April 5th, 1847.

NEWARK, *March* 3, 1848.

I have examined with much care Fulton's System of Penmanship, lately published by Messrs. A. S. Barnes & Co., of New York. My attention has been called to the subject of teaching penmanship in our public schools, from the very manifest want of any system that seemed at all suited to the character of our Ward Schools. Mr. Fulton's system I deem to be the best I ever saw, and I have no hesitation in recommending it. There is an exactness about Mr. F.'s method of teaching this art, which seems to defy the possibility of pupils becoming any thing but accomplished proficients.

I have taken means to procure the introduction of one set of the charts and a number of the copy-books in our schools as an experiment, and so well satisfied am I that the system is what we need, that I shall use early measures to have them introduced more extensively.

Yours, &c., JNO. WHITEHEAD,
Commissioner of Public Schools for the city of Newark

From the Superintendent of Monroe County, West District.

MR. LEVI S. FULTON:

Dear Sir:—I am well pleased with the examination of your series of "Chirographic Charts, for the purpose of illustrating and teaching the principles of Penmanship." One of the greatest obstacles in the way of the scholar's improvement in our schools, is the frequent change of teachers. Under the instruction of every new teacher, the scholar commences to learn a new hand, by attempting to copy that of the teacher: the consequence is, that he rarely obtains a good permanent hand. His efforts so often failing of success, he becomes discouraged, and ready to abandon the exercise as a vexatious and hopeless task.

By the use of your charts, applying the principles as taught in your book, the teacher and pupil will be very much aided in the exercise; the teacher illustrating the principles from the chart, and the pupil practising upon them.

I rejoice that you have so arranged these principles, that the art of good penmanship will be placed within the reach of all who desire to attain this necessary accomplishment, and I will indulge the hope, that your works may obtain that extensive circulation which their merits so richly deserve.

Desiring your best success in this praiseworthy undertaking, I shall ever remain your most obedient and humble servant,

JULIUS A. PERKINS,
County Superintendent, Monroe co., West District.

Spencerport, Dec. 26, 1846.

LEVI S. FULTON, Esq.:

Dear Sir:—Your theory and practice of Penmanship, which I have had several opportunities to see tested and applied, is, in my opinion, truly philosophical, and fully justifies the high estimate formed of it by all to whom it has been exhibited.

I have examined the plan of your proposed publication, and entirely approve of it. It seems to me that such a work is greatly needed, and that its adoption as a text-book would greatly facilitate the acquisition of a beautiful but hitherto vexatious branch of education.

REV. O. R. HOWARD, A. M.,
(Late) Principal of Fairfield Academy.

Lyons, Dec. 1, 1846.

PENFIELD, *Jan.* 31, 1848.

Dear Sirs:—It is with pleasure I inform you that your *Chirographic Charts* are in use in the Union School of this village, with admirable success. Serious diffi-

culties which presented themselves to the learner of writing by the old system (imitation merely) are entirely overcome.

The fixed rules for the formation of each principle separately, and most especially the general arrangement of your Charts, are *desiderata* hitherto unreached by any system of penmanship with which I am acquainted.

In my humble opinion, they must meet with universal approbation.

Very respectfully, yours, &c., WM. D. SHUART.

MESSRS. FULTON & EASTMAN:

Dear Sirs:—I have carefully examined your *Chirographic Charts* and *Key*, and am pleased to find your system of penmanship one that at once recommends itself by its perfection and simplicity—requisites indispensable to successful application in our schools, and for a lack of which, others have proved failures. As teachers themselves are not unfrequently inferior penmen, and have gained their own knowledge of this branch of education by a random practice, they are wholly unable to impart it to their pupils. Your system obviates this difficulty, by giving the teacher a resource from which to supply his own deficiency, and hints for the successful application of whatever knowledge of the art he may possess.

Your charts are in use in the Union and Select schools of this village, and also in other schools of this town and county, and with the happiest success. The scholars, charmed with the novelty which the system continually presents, and the ease with which they master its principles, vie with each other in their efforts to excel, and are rewarded by acquiring a beautiful "hand" and neat mechanical execution—and at the same time, the teacher is relieved from the perplexing practice of *random* teaching, so universal in our schools.

JAMES M. PHINNEY,
County Superintendent, Monroe Co., East Dist.

Penfield, Nov. 1, 1847.

From the Rochester Monthly Educator.

We believe that Mr. Fulton is the first author who has attempted to teach the art of penmanship *by rule*. Heretofore, *imitation* has been almost the sole principle used to direct the student in acquiring a knowledge of chirography, and as every teacher has a system peculiar to himself, no uniform plan of instruction could be successfully introduced into our common schools. Mr. Fulton has rendered an essential service to the cause of education, in perfecting a system which does not, at every change of teacher, require a variation in the handwriting of the pupil. One advantage which must result to the teacher from the use of these charts, is the great amount of time and labor that will be saved thereby—the old method of writing separate copies for each scholar being entirely dispensed with. We feel confident that teachers and parents who will take time to examine this system of penmanship must be convinced of its superiority over all others.

FULTON & EASTMAN'S BOOK-KEEPING.

A PRACTICAL SYSTEM OF BOOK-KEEPING BY SINGLE ENTRY.

Containing three distinct forms of books, adapted for the Farmer, Mechanic, and Merchant—to which is added a variety of useful forms for practical use, viz.: Notes, Bills, Drafts, Receipts, &c. &c.: also a Compendium of Rules of Evidence applicable to Books of Account, and of Law in reference to the Collection of Promissory Notes, &c. By LEVI S. FULTON and G. W. EASTMAN, authors of a complete System of Penmanship.

ROCHESTER, *Feb.* 12, 1848

L. S. FULTON, Esq.:

Dear Sir:—I have examined with much satisfaction your System of *Book-Keeping*, and take pleasure in recommending its adoption to my immediate friends and others.

It is simple and easily reduced to practice, and possesses a peculiar adaptation to the wants of the community for which you design it.

The plan for Merchants' Books, which I examined more critically than other portions of the work, is very neat, compact, and economical, and must ensure a great degree of accuracy in keeping accounts.

I believe your work will meet the present wants of community.

Very respectfully, your friend, ELIJAH BOTTUM,
Book-keeper for John M. French & Co.,
Rochester, N. Y.

I have examined Messrs. Fulton & Eastman's "Practical System of Book-Keeping by Single Entry," and am pleased with the work. As a branch of Education, Book-Keeping is well deserving a high estimation; and, I will add, there is none of equal importance and utility more generally neglected, particularly in our public schools.

The work above alluded to, is plain, simple, and comprehensive, and well adapted to meet the wants of the business community. In many respects I deem it superior to any other work of the kind with which I am acquainted. I shall recommend it to the schools under my charge.

JOHN T. MACKENZIE,
Lyons, May 8, 1848. Town Superintendent.

FULTON & EASTMAN'S BOOK-KEEPING.—We had supposed that, in the multiplicity of works on Book-Keeping, hardly any thing valuable remained to be suggested by later authors, should any such present themselves. But we have been convinced of our short-sightedness in examining the work with the above title, now before us. The work is principally designed for schools—for common schools—but should be in the hands of every Farmer, Mechanic, and Merchant in the land. It opens with a system of account-keeping for farmers, followed by one for mechanics, and this, in turn, by an admirable and comprehensive system of mercantile Book-keeping, which, for its simplicity, and time and labor savin

properties, possesses advantages over all other systems with which we are acquainted. These advantages are thus set forth by the authors in their preface, and an examination of the work will convince any man competent to judge, that they are not over-estimated:

"It [the system spoken of] saves more than one-third of the time in journalizing, and at least three-fourths of the labor in posting. It requires but twelve lines in the Ledger to post a year's business, while in the ordinary way as many pages may be necessary. In settling with a person at the end of a year, you have only to refer back to twelve places in the Journal to show him all the items of his account, whereas in the ordinary manner of keeping books you might have to refer to five hundred."

Part II. of the work, which was prepared by a distinguished member of the bar, comprises "rules of evidence and general rules of law in relation to bills of exchange, promissory and chattel notes, checks, books of account, &c., together with a large number of forms *useful to all classes* of business men; such as deeds, bonds, mortgages, bills of sale, powers of attorney, bills of exchange, notes, receipts, &c.

This invaluable work contains 232 pages of duodecimo, is printed in the best style of Messrs. A. S. Barnes & Co., of New York, on an excellent quality of paper, and is afforded at the very low price of 50 cents per copy.—*Wayne Co. Whig*

LYONS, *May* 8, 1848.

I have examined "Fulton & Eastman s Book-Keeping," and regard it as a useful work on the subject of which it mainly treats. Its methodical arrangement, its simple and ready modes of keeping accounts, adapted to the business of the Farmer, Mechanic, or Merchant respectively, and the neat style in which it is executed, recommend very strongly its use in primary institutions of learning, and especially in common schools. It is to be hoped that its general introduction as a school-book, will cause the art of Book-keeping to be regarded as one of the indispensable requisites of what is termed a good English education.

JAMES C. SMITH.

From the Albany Spectator.

FULTON & EASTMAN'S BOOK-KEEPING.—New York: A. S. Barnes & Co., 1848.

We are very much pleased with the design and execution of this work. It is exceedingly practical; being by single entry, containing three different forms of books, for the Farmer, the Merchant, and Mechanic. To these are added notes, bills, drafts, receipts, and a compendium of rules of evidence applicable to books of account, and of law in reference to the collection of promissory notes. A work of such a character, and of so much practical value, speaks for itself, and stands in need of no commendation from us to ensure it a large sale among *all classes.*

SCIENCE OF THE ENGLISH LANGUAGE.

CLARK'S NEW ENGLISH GRAMMAR.

A Practical Grammar, in which WORDS, PHRASES, and SENTENCES are classified, according to their offices, and their relation to each other: illustrated by a complete system of Diagrams. By S. W. CLARK, A. M. Price 50 cts.

From the Rahway Register.

It is a most capital work, and well calculated, if we mistake not, to supersede, even in our best schools, works of much loftier pretension. The peculiarity of its *method* grew out of the best practice of its author (as he himself assures us in its preface) while engaged in communicating the science to an *adult* class; and his success was fully commensurate with the happy and philosophic design he has unfolded. *Technicality*, as technicality, our author unceremoniously discards, and substitutes on the pupil's part *rational practice* in ascertaining the *office* of words in sentences, rather than the usual mode of perplexing his memory with their mere names and *forms*.

From the New York Tribune.

"The Science of the English Language—A Practical Grammar, in which Words, Phrases, and Sentences are classified according to their offices and their relation to each other. Illustrated by a complete system of Diagrams. By S. W Clark, A. M.," is a new work which strikes us very favorably. Its deviations from older books of the kind are generally judicious and often important. We wish teachers would examine it.

From the Courier and Enquirer.

"A Practical Grammar of the English Language" by S. W. Clark, A. M., has just been published by Barnes & Co. It is prepared upon a new plan, to meet difficulties which the author has encountered in practical instruction. Grammar and the structure of language are taught throughout by analysis, and in a way which renders their acquisition easy and satisfactory. From the slight examination, which is all we have been able to give it, we are convinced it has points of very decided superiority over any of the elementary works in common use. We commend it to the attention of all who are engaged in instruction

From A. R. Simmons, Ex-Superintendent of Bristol.

MR. CLARK:

Dear Sir:—From a thorough examination of your method of teaching the English language, I am prepared to give it my unqualified approbation. It is a plan original and beautiful—well adapted to the capacities of learners of every age and stage of advancement. Believing that the introduction into our Common Schools and Academies of a text-book on grammar containing your SYSTEM and METHOD will greatly facilitate the acquisition of the science of the English language, I respectfully suggest that it be permitted to come before the public.

Respectfully yours,

A. R. SIMMONS, Grammar Teacher

Bristol, August 26, 1847